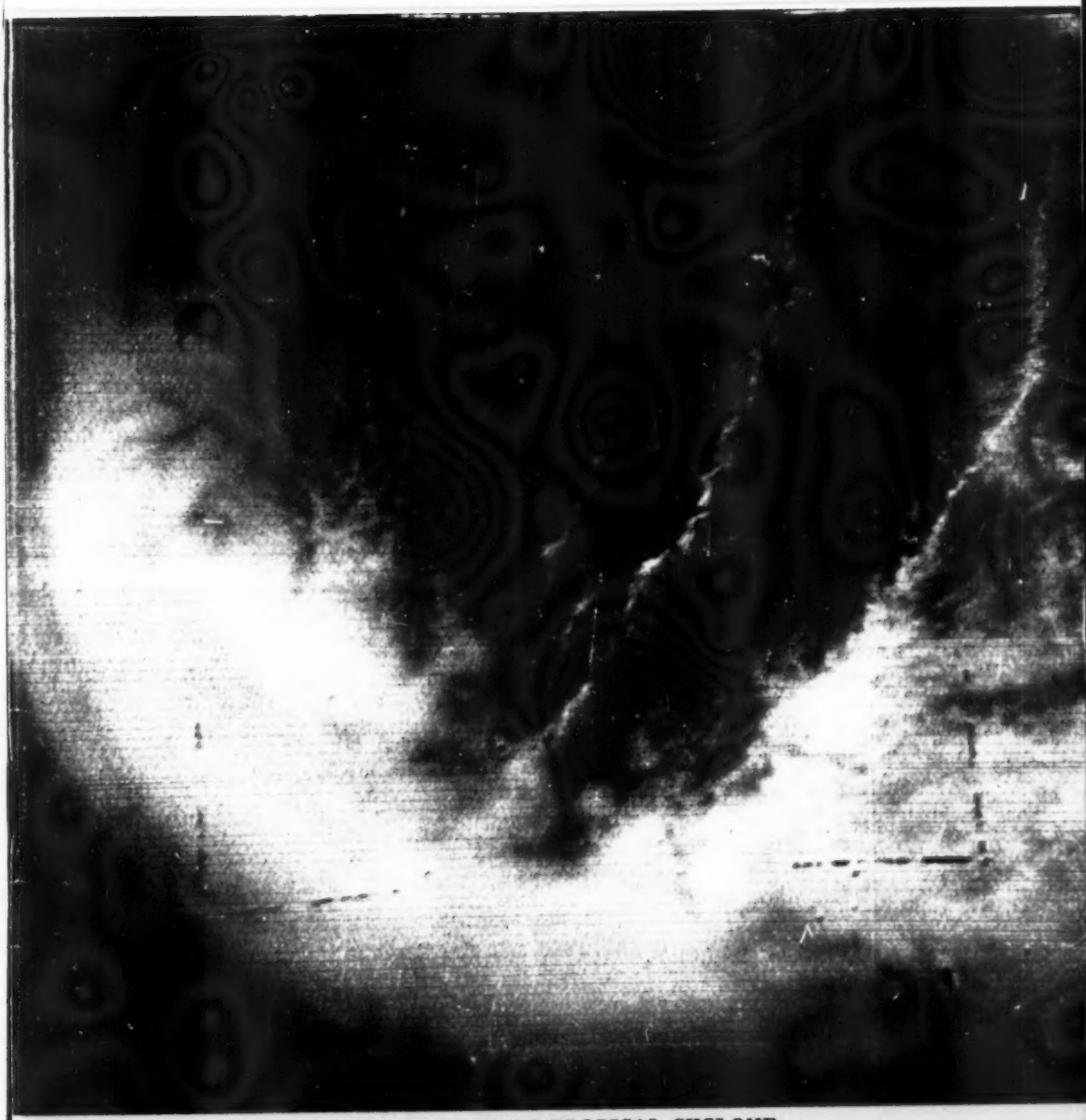
Weatherwise



TIROS PHOTO OF TROPICAL CYCLONE

Volume 13, Number 4 August 1960

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor* HENRY W. BULKLEY, *Associate Editor*

AMS Calendar 1960–61

New York City	With the Instrument Society of America	26–30 Sept.
New York City	With the annual meeting of the AAAS	26–31 Dec.
New York City	Annual Meeting and joint sessions with Institute of Aeronautical Sciences and N. Y. Academy of Sciences	23–26 Jan.
Chicago, Ill.	General Meeting	21–23 March
Washington, D. C.	General Meeting with AGU	20–22 April
Davis, Calif.	General Meeting with Pacific Div., AAAS	12–17 June
Miami, Fla.	Conference on Hurricanes	27–30 June
Honolulu, Haw.	Tenth Pacific Science Conference	Aug.–Sept.
Kansas City, Mo.	Ninth Weather Radar Conference	October
Atlanta, Ga.	4th Conference on Applied Meteorology	8–11 Nov.
Tallahassee, Fla.	General Meeting	14–16 Nov.
St. Louis, Mo.	4th Conference on Agricultural Meteorology	November
Denver, Colo.	With the annual meeting of the AAAS	26–31 Dec.

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Front Cover: Tiros photo of tropical cyclone centered about 300 miles north of the northern tip of New Zealand about 0300Z on 10 April 1960. NASA photo courtesy USWB.

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A National Center for Atmospheric Research

Walter Orr Roberts Named Director

A NATIONAL Center for Atmospheric Research has been established by the National Science Foundation to meet a long felt need in this field of science. The Center will be a unique organization, and in no sense "just another laboratory."

First, the Center will be an *intellectual center* where leading scientists with diverse backgrounds can focus their talents on atmospheric problems. It is planned to have a permanent staff and an approximately equal number of visiting scientists from this country and all over the world. The Center will be interdisciplinary in character, bringing the resources of engineering, chemistry, physics, and mathematics to bear on atmospheric science. The Center is expected to provide a bold imaginative approach to the vast problems of the atmosphere.

Second, the Center will be a *research planning center* for large-scale programs that cannot be attacked by individual groups, and for this the Center will use *ad hoc* teams of university scientists to plan such major programs. While providing the intellectual nucleus around which major plans will crystallize, the Center will in no sense direct research in universities. Rather it will stimulate the planning of joint research operations in which each group involved will participate according to its interest and talents.

Third, the Center will be a *research operations center*. For each cooperative research program undertaken, the Center will synchronize and coordinate the research operations, which may be of a world-wide nature. The Center will arrange for and schedule necessary airplane flights, rocket launchings, and other complex operations, serving as a scientific "Combat Information Center" for each major program. In these operations maximum use will be made of existing government facilities insofar as they can be made available by the responsible agencies.

WALTER ORR ROBERTS

The NSF plans to let the Center facilities grow as the program develops and the needs become clear. Because its activities will be nation-wide and probably world-wide, all facilities may not be located at a single place. Some of the necessary vehicle launching sites for high-altitude balloons and rockets must of necessity have special locations. There will certainly be a central interdisciplinary laboratory and offices for the staff, but operational facilities may be widely dispersed.

The National Science Foundation plans to provide a basic core of financial support for the operation of the Center and additional

funding as required for major cooperative programs.

———— · ————

The appointment of Walter Orr Roberts of the High Altitude Observatory, Boulder, Colorado, as director of a national center of atmospheric research was announced on 27 June 1960 by Alan T. Waterman, director of the National Science Foundation, and Henry G. Houghton, chairman of the University Corporation on Atmospheric Research (UCAR). A NSF contract of $500,000 with UCAR to assist in establishing the center has also been announced.

The member universities of UCAR are Arizona, California, Chicago, Cornell, Florida State, Johns Hopkins, M.I.T., Michigan, N.Y.U., Pennsylvania State, St. Louis, Texas A. & M., Washington (Seattle), and Wisconsin.

"The appointment of Dr. Roberts marks a gratifying turning point in organization of the new research group," said Dr. Waterman. "His many achievements in research, and his exceptionally able administration of the High Altitude Observatory, ensure that this new venture will be established on a sound and productive basis. The atmospheric sciences have suffered from neglect and lack of trained research personnel. Walter Roberts and the research group he forms will be able to lead the way in overcoming these problems. Needless to say, we are delighted that he has accepted the position."

Dr. Houghton of MIT and UCAR, commenting upon the importance of the actions, said: "The increasing impact of weather on our national security, economy, and welfare requires that we obtain a much more complete understanding of our fickle atmosphere. This new center, working in close collaboration with university scientists, will provide the facilities needed for the mounting of a basic research effort commensurate with the magnitude and importance of the challenging unsolved problems of the atmosphere."

He added: "The success of this new center will depend critically upon the wisdom and leadership of the Director and we are confident that in Dr. Roberts we have found a man uniquely fitted for the challenging tasks ahead."

Dr. Roberts was born on 20 August 1915 in West Bridgewater, Mass. Growing up on a farm, he developed a love of the outdoors which greatly assisted in making life in the Colorado Rockies congenial. He was graduated from Amherst College in 1938 and went on to graduate work at Harvard University where he earned his A.M. (1940) and Ph.D. (1943) in the field of astro-physics. During his Harvard days Dr. Roberts met Janet Naomi Smock, a student at Wheaton College. They were married in June 1940 and soon left their academic groves to establish the new coronograph station at Climax, an 11,000-ft. elevation at Fremont Pass. The Roberts now have four children.

During World War II, Dr. Roberts reported regularly from Colorado to Washington on solar disturbances that might blank out short-wave radio communications. His warnings assisted the armed forces in forecasting electro-magnetic disturbances and in making the best use of their communication facilities. In 1946 the Climax station was reorganized as a non-profit institution, and in 1953 the High Altitude Observatory became a part of the University of Colorado. Dr. Roberts also holds the position of professor and head, Department of Astro-Geophysics at the University. Dr. Roberts will continue to hold this position while he organizes the national atmospheric research group for UCAR.

Since its founding the High Altitude Observatory has carried on an important program of research with a solar coronograph to study the sun's outer gaseous envelope. Dr. Roberts has long been interested in the relationship between disturbances on the sun and the course of weather on the earth. He has given many papers at professional meetings devoted to solar-terrestrial weather relationships. Dr. Roberts is currently an active council member of the American Meteorological Society.

The Role of a Meteorologist in an Insurance Company

DON G. FRIEDMAN AND ROBERT L. HENDRICK,
The Travelers Insurance Companies, Hartford, Connecticut

NEARLY every industry in the nation has some economic stake in the weather, but only the insurance industry measures its liability to weather damage in terms of hundreds of billions of dollars and counts its annual incurred losses due to weather in terms of hundreds of millions of dollars. The industry has accepted weather risks to property, to crops, and to various outdoor activities totaling several hundred billion dollars. A rough estimate of the total current liability on property insurance alone reaches between 200 and 300 billion. That this kind of protection against weather loss is needed is illustrated by the two to three billion dollars paid out in weather-caused claims during the past ten years.

The principle of insuring property against weather loss is essentially the same as in other types of insurance. The individual property owner substitutes the small fixed cost of the insurance premium for the risk of incurring uncertain and possibly unmanageably large losses. An insurance company can assume the risk from a large number of individuals who are subject to approximately the same chance of loss from a particular peril since losses will not occur to all individuals at the same time and the premiums of the many will be available to pay the losses of the unfortunate few. The spreading of risk over a large number of individuals or properties is a basic principle of all insurance.

Insuring against the uncertainties of

Roofs are especially subject to wind damage. This Kansas homeowner watches winds approaching hurricane force tear the shingles from his roof. Acme photo.

damaging weather, however, involves some special problems that do not occur in most other types of insurance. For example, the scale of potentially destructive storms can be sufficient to increase simultaneously the chances of loss to all policyholders over large geographical areas. Rating and underwriting practices must take into account special problems of this type that derive from the nature of weather.

In view of the volume of business and the special problems associated with insuring against weather losses, it is apparent that the meteorological profession has a role to play in the insurance industry. In 1955, The Travelers Insurance Companies made the decision to add a number of meteorologists to their professional staff. During the past five years these meteorologists have been utilized in many of the diverse operations of the company. The role of meteorologists in the areas of rating, underwriting, claim, investment, and public service will be discussed.

RATING

Rating involves the determination of the amount of premium needed to cover future losses. The probability of an individual loss, of multiple losses, and the spread of risk are important factors in rating. Premium rates on many types of property insurance, including dwelling insurance, are established by Rating Bureaus. The Bureaus use actuarial science and base rates primarily on ten years or less of loss experience. Currently under consideration is the question of whether or not our relatively long period of climatological records could contribute to the making and stabilization of rates.

There are special cases where rates are set by the individual insurance companies. An example of this type of risk is radio and television transmission towers. High wind, sometimes in combination with icing, has brought more than one hundred of these towers crashing down during a recent ten-year period. The Travelers meteorologist assists in evaluating the severity of the weather risk to towers. Important factors are tower location and design. This is not rating in the direct sense, but it is evaluating the adequacy of rates by estimating the probability of loss.

UNDERWRITING

A much larger role has been played by the meteorologist in the area of underwriting. The underwriting operation involves accepting, rejecting, and reinsuring risks in order to maintain an overall quality of risk and spread the liability.

Meteorologists at The Travelers are occasionally requested by underwriters to evaluate the weather peril on special risks where experience is lacking. One example was the evaluation of the weather hazard to a group of mobile homes located on a South Carolina beach. However, most of the work with the underwriters has not been in estimating the weather hazard on special risks, but in aiding the underwriter make decisions concerning the type, and adequacy of spread, of risks that are already on the books. Most of this work has dealt with the major type of property insurance against weather loss, the Extended Coverage Endorsement.

Extended Coverage is the endorsement that is usually added to the fire policy on dwellings and commercial buildings to extend coverage to include a half dozen or more additional perils, including windstorm and hail. Windstorm and hail account for a large majority of the total Extended Coverage losses, illustrating that Extended Coverage is, in reality, a form of weather insurance.

During the nine-year period, 1949 through 1957, paid losses in Extended Coverage totaled two billion dollars for all insurance companies. These losses fell about equally into two classes: first, the major loss-producing storms, such as hurricanes or tornadoes in heavily populated areas, and second, the innumerable losses scattered in time and place due to severe thunderstorms, the more ordinary cyclones, and also tornadoes that remain in rural areas.

An idea of the types and frequencies of the major loss-producing storms can be gained from the statistics compiled by the National Board of Fire Underwriters. The National Board assigns a catastrophe number to any single storm or single cause that results in a total loss to all companies of a million dollars or more. Since January, 1949, there have been 105 such catastrophes. Six of these were due to explosions, two were due to earthquakes. The remaining 97 were caused by

either wind or hail. Hurricanes, tornadoes, intense cyclones, hail storms, and combination hail and wind storms were the main storm types leading to losses of one million or more dollars. The greatest single loss was the well-known Northeast Storm of November, 1950. This east coast cyclone caused a total loss to all companies of $175 million, slightly more than the losses due to either hurricane Carol or Hazel.

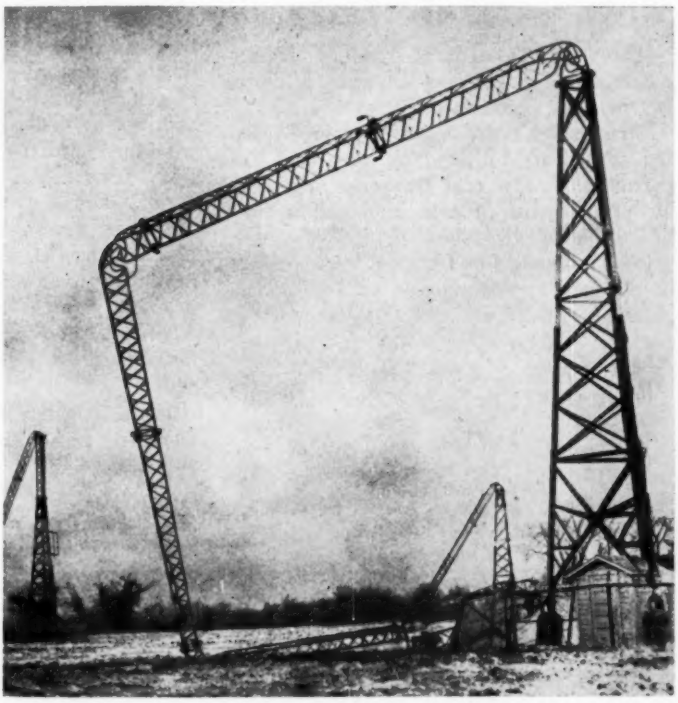
An example will illustrate how a meteorologist contributes to the work of underwriting Extended Coverage. Over a five-year period, The Travelers suffered large losses in Extended Coverage in a Mid-western area. The problem was to determine if these losses were due to an unusual frequency or intensity of severe weather or if this loss experience was a normal climatic expectancy.

In this study, pertinent data on the underwriting aspects of the losses, such as the location, amount and cause of losses, were compared with the coincident weather data over the 5-year period. The long-term climatological records of the important storm types and weather elements were then examined for secular changes. Loss expectancies in the future were then based on weather-loss relationships and the long-term history of the critical storm types and weather elements.

In this study it was interesting to find that a major portion of both the number and total amount of extended coverage losses were due to severe thunderstorms. It was rather surprising to note that hail was a factor in more than two-thirds of the total amount of losses.

This study demonstrated that the heavy losses in the past five years were due to a normal frequency of loss-producing storms which could be expected to continue in the future. These results were subsequently used as the basis for several underwriting changes in the area. Similar studies were carried out for other areas.

At the present time, The Travelers Research Department is initiating a more general study to define the risk of property loss due to weather in terms of the climatological probabilities of damage-producing weather elements. This information will be designed



Radio and television towers present special problems in rating and underwriting. These Chicago towers were destroyed by a combination of ice and 50 mph winds. *Chicago Tribune* photo.

Hail is a factor in a majority of extended coverage losses in some central sections of the United States. These windows were smashed during an Oklahoma hailstorm in 1956. (From Snowden Flora. *Hailstorms of the United States.* University of Oklahoma Press.)

to supplement the loss experience which is the principal measure of the weather peril.

CLAIM

The Claim Department examines, investigates, and approves the payment of losses covered by a particular contract.

Meteorological data on widespread damaging storms are provided to the Claim Department in order that they may prepare in advance for the processing of claims from affected areas. In some instances, the meteorologist has aided in determining the validity of claims. Precipitation, wind speed, temperature, and the presence of snow or ice on the ground are often important factors at the time losses are incurred.

INVESTMENT

In order that the premium dollars, aside from their role in paying benefits to policyholders, may share in and contribute to our economic growth, an insurance company invests a portion of its premium income in home loans, commercial building loans, farm mortgage loans, corporate and Federal, State and local bonds and other carefully selected securities. Interest and dividend returns from these investments are an important factor in making rates—which would otherwise be much higher—and further strengthen reserves which provide an additional safeguard for the policyholder.

In some cases, meteorology has played a part in the selection and distribution of loans, in particular, farm mortgage loans. The possibility exists that the market value or earning power of a farm property may decline and one factor that can cause a decline is weather. Several studies have been made in which weather hazards affecting the farm mortgage program have been examined.

A few years ago, the drought in the Southwest, especially in southwest Texas, was of concern. This led to the question of whether or not periods of drought could be foreseen during the next ten to twenty years. An analysis of annual rainfall data, which was shown to be an adequate measure of drought as it affects the farm mortgage program, failed to show any predictability used either alone or associated with terrestrial or extraterrestrial influences. Categorical prediction of annual rainfall was not possible. Therefore, the probabilities of given amounts of annual rainfall were estimated. The use of probabilities was suggested by the fact that the time series of annual rainfall at stations in the region had many of the characteristics of random series. Probability estimates were obtained by fitting the empirical rainfall distributions with the incomplete gamma function. Inasmuch as extended periods of below normal rainfall can be expected to occur in a random series, probabilities were used to estimate the risk of abnormally low rainfall in a given year or sequence of years. The long-term drought outlook, expressed in terms of probabilities, was used as a factor in the farm mortgage program in the area of concern.[1]

In the irrigated areas of the West the farm mortgage loan program is affected by the ground water situation. Several rather extensive studies were made; these reviewed the physical nature of ground water reservoir, surveyed the history of irrigation development, and drew inferences as to the future trends that may bear on farm investment policies.

In another study the frost hazard in the Coachella Valley in California became

important in farm investment considerations.[2] Temperature records in the valley stations were mostly five years or less in length. But one station, Indio, with a record of more than 25 years, was used as a bench mark and the long-term characteristics of below freezing temperatures were studied at this station. Low temperatures at the other stations were then related to temperatures at the bench mark station during the five-year period. The relationships developed defined the frost hazard over the area of interest.

Another area of interest in farm mortgage investment is agricultural productivity especially in newly developed areas where certain crops are being grown for the first time. Some work has been done relating crop productivity to climate in those areas where certain crops have been grown for some time, then inferring productivity from climate factors in areas where these same crops have not yet been grown.

PUBLIC SERVICE

Finally, we come to an area in which an insurance company is vitally interested: community responsibility and public service.

Meteorologists have been utilized at Travelers during the past five years to provide Connecticut and much of New England and eastern New York with both regular and special weather forecasts on radio and television. In addition to thirteen regular daily broadcasts are the special boating weather programs in summer and skiing weather programs in winter.

Through the establishment of cooperative stations with the Connecticut State Highway Department, weather and road information can be coordinated. This is especially valuable during snow and ice conditions when highway accident rates are at a maximum. It was found that in Connecticut the highway accident rate during any kind of precipitation was double the dry weather rate. During snow and sleet the accident rate increases to three times the dry weather rate. Making weather and road information available to the public is in keeping with The Travelers aim of assuming community responsibility and acting in the public interest.

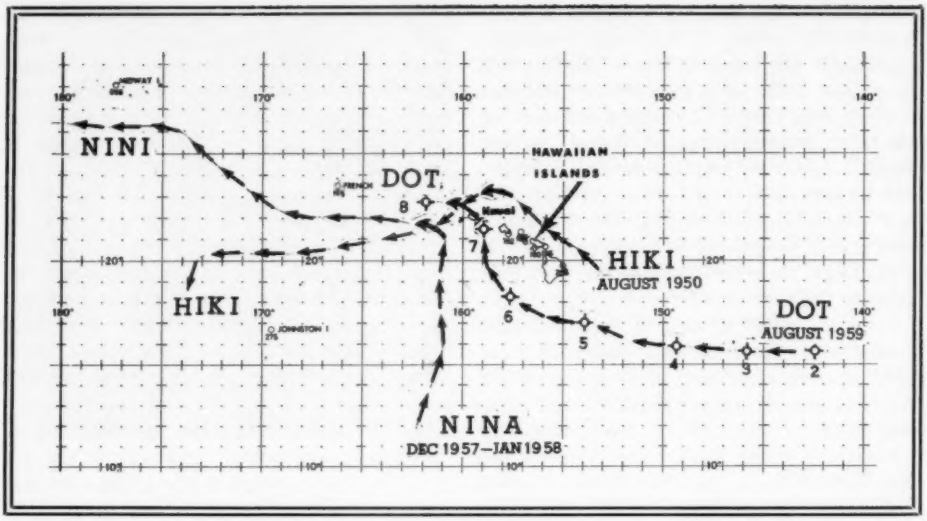
The enormous stake shared by the public and the Company in improved forecasts prompted The Travelers meteorologists to undertake several forecasting studies. East coast hurricanes, with their record of destruction of life and property during the past two or three decades, were a natural subject for one of these studies. Statistical techniques for predicting not only the position and intensity of hurricanes but also for evaluating the storm hazard at any particular point or over any area were derived, tested, and put into operational use. It is hoped that this and other forecasting studies will benefit both the public and the insurance companies through improved forecasts and warnings and a resultant lessening of injuries and destruction.

In addition to rating, underwriting, claim, investment, and public service, there are still other insurance company operations that present possibilities for meteorology to play an interesting role. Further development of meteorological applications to insurance operations at The Travelers is anticipated.

REFERENCES

1. Friedman, Don G., 1957: "The Prediction of Long-Continued Drought in South and Southwest Texas." *The Travelers Weather Research Center Occasional Papers in Meteorology No. 1,* Hartford, Connecticut.
2. Friedman, Don G., 1959: "A Frost Survey of the Coachella Valley in Southern California." *The Travelers Weather Research Center Occasional Papers in Meteorology No. 3,* Hartford, Connecticut.

Bob Hendrick, coauthor of this article, discusses the weather situation and forecast before WTIC-TV audience. Regular and special television and radio broadcasts are an important function of the Travelers Weather Service.



The tracks of the three tropical storms which reached hurricane force in the Hawaiian Islands in the past 57 years of records: Hurricane HIKI, 15–30 August 1950; Hurricane NINA, 29 December 1957–7 January 1958; Hurricane DOT, 2–8 August 1959.

Dot—Hawaii's Third Hurricane

ENSIGN ROBERT D. STEARNS, *U. S. Fleet Weather Central, Pearl Harbor, Hawaii*

IN August 1959, for the third time in the 57 years of local meteorological records, the Hawaiian Islands came under the influence of a fully-developed hurricane. As indicated by the records, the 1959 storm was the largest and most intense thus far. The other occurrences were Hurricane Hiki in August 1950 and Hurricane Nini in December 1957.

Hurricane Dot was first discovered as an intense tropical storm in the vast ocean area between Hawaii and Mexico by the SS SONOMA which reported 45-knot winds and heavy rain showers at 15.7N 141.2W at 2100Z on 1 August 1959. This placed the storm about 800 miles east-southeast of Hilo on the Island of Hawaii.

The first warning was issued at 0000Z on 2 August by the recently-formed Joint Hurricane Warning Center. The JHWC is composed of the Navy's Fleet Weather Central (Pearl Harbor), the Air Force Kunia Forecast Center, and the U. S. Weather Bureau (Honolulu International Airport). Each unit prepares a "rough" draft of the warning to be issued currently. Then, by means of a three-way telephone conference call, the three individual outlooks are discussed, evaluated, and an agreement reached. This method results in a uniform warning being issued by each unit (Fleet Weather Central, Kunia Forecast Center, and U. S. Weather Bureau all issue separate warnings), thus avoiding the confusion that results from lack of agreement when three separate warnings are issued simultaneously. It is also felt that the collaboration of the three separate viewpoints

contributed much to the accuracy of the forecasts.

Forecasting Dot's course and speed was a problem largely confused by lack of data. The only surface synoptic reports were those furnished by the *SS SONOMA* and one other ship 400 miles away to the north. Upper-air data were sparse; the only reports were those from Hilo, Lihue, Johnson Island, and station ship 4YN (30N 140W).

The first reasonably accurate center fix resulted from the following message sent by the *SONOMA:* RECORDED LOW PRES OF 963PT4 AT 01/2300Z X WIND SHIFT AND BRM INDICATES VESSEL PASSED THRU SRN PART OF STORM CNTR 01/2300Z.

Based upon the *SONOMA*'s position at that time Dot's center was given in the 02/0000Z warning as 15.8N 142.0W. This warning upgraded Dot to a hurricane, listing maximum winds as 90 knots.

From 02/0000Z until the first aircraft fix at 03/0000Z, Hurricane Dot's positions were determined mostly by extrapolation. Based upon the history of previous tropical disturbances in this area, the 02/1200Z and 02/1800Z warnings listed the maximum winds as 85 knots and 75 knots respectively, indicating a slow weakening trend, as the previous disturbances had always been observed to do as they moved west.

The 03/0000Z aircraft reconnaissance report revealed that Hurricane Dot was far larger and more intense than previously suspected. A central pressure of 952 mb was recorded by dropsonde. Surface winds were not observed, but were estimated to be in the vicinity of 120 knots, based upon the 952 mb central pressure. The observers reported that cloud development was very extensive, particularly towering cumulus (tops at unknown height) in the northern and eastern semicircles. Heavy turbulence and shower activity

Storm surf breaks on a bathing beach along the eastern coast of Oahu during Dot. *Honolulu Advertiser* photo.

A large shed-type building was demolished by Dot. *Honolulu Advertiser* photo.

at flight level (approximately 10,000 feet) made observing difficult. The eye was clearly defined, however, by intense bands of precipitation and dense cloud walls. It was also quite large, being about 35 miles in diameter.

Dot's movement was regular, a fact that greatly aided forecasting. From the time of discovery until the gradual recurvature began at approximately 04/0000Z, Dot's movement was slightly north of due west at about 9 knots. As recurvature began, her forward speed gradually increased to 11–12 knots. It is interesting to note that Dot, as in the case of Hurricane Hiki (August 1950), did not show the rapid acceleration during recurvature that is characteristic of Atlantic hurricanes and western Pacific typhoons.

Hurricane Dot remained an intense hurricane throughout most of her existence, with maximum winds between 100 and 120 knots (some estimates even went as high as 140 knots), with 50-knot winds covering an area of radius 80–120 miles. The first indication of weakening did not occur until 06/1800Z, when maximum winds dropped to 90 knots, and 07/0000Z, when the maximum winds further decreased to about 70 knots.

The eye of Hurricane Dot crossed the Island of Kauai between 07/0400Z and 07/0600Z. Lihue, the USWB observation station on Kauai, recorded maximum winds of 55 knots at 07/0500Z. Rain was continuous from 06/1700Z until 07/0900Z. Higher winds were recorded elsewhere, with a maximum of 87 knots being recorded at Kilauea Point lighthouse at 07/0600Z. Ed Banken, USWB observer from Honolulu, made a trip to Kauai to survey storm damage and stated that he felt the topography had a great deal to do with the high reading at Kilauea Point lighthouse. "Eye" conditions were not recorded at Kilauea Point, but Lihue Airport observed "eye" conditions from 07/0512Z (shortly after the maximum winds were recorded) until 07/0600Z.

Storm waves of Dot are running 20–30 feet at Waianae, Oahu. Photo by author.

After crossing the Island of Kauai, Dot, now considerably "disorganized" and weakened, ceased her recurvature between 07/1200Z and 07/1800Z, turning once again to the west northwest. Decaying rapidly, by 08/0000Z, Dot had lost all "eye" characteristics and had reverted to an open wave, with maximum winds of only 45 knots. The last warning was issued at 08/0600Z; Dot had become stationary with winds of only 35 knots and was dissipating rapidly.

The greatest damage done to the Hawaiian Islands occurred on the islands of Hawaii, Oahu, and Kauai. The islands of Maui, Molokai, and Lanai received heavy rainfall, high surf, and gusty winds, but little damage was recorded.

Dot entered the Hawaiian Island chain with her passage 90 miles south of the island of Hawaii at approximately 05/1200Z. Although Hilo was completely unaffected by the hurricane winds (due to the surrounding mountainous terrain), heavier than normal rainfall was observed. South Point was battered by 30 to 40-foot seas and gusty winds to 65 knots, but little damage was done to this area due to the sparseness of habitation. The famous resort area along the Kona Coast was hardest hit, suffering an estimated $35,000 to $50,000 damage, mostly due to the high surf and local flooding. The well-known Kona Inn received $20,000 to $25,000 damages, according to newspaper reports.

Oahu also had damage from the high surf, some local flooding, and gusty winds which were recorded as high as 50 knots. Most of the damage occurred along the Waianae coast.

The island of Kauai was hardest hit, suffering an estimated $6 million damage, and was subsequently proclaimed a disaster area. Four to six hundred houses were damaged, many of which were almost completely destroyed. The sugar plantations, which represent a large portion of the island's economy, suffered very extensive losses. Lihue Plantation, largest on the island, received the greatest blow: an estimated $1.5 million crop and $215,000 in equipment and structural damage.

Statistically, there were 16 fixes by aircraft reconnaissance at almost regular six-hour intervals commencing with the first fix on the 3rd and terminating with the last reconnaissance on the 8th. Land-based radar was also used during the short period while the hurricane was in the immediate vicinity of Oahu. There were 27 warnings issued by the Joint Hurricane Warning Center, 23 being hurricane warnings.

Large seas of Dot are breaking across a 12-ft. breakwater at Pokai Bay, Waianae coast, Oahu. Photo by author.

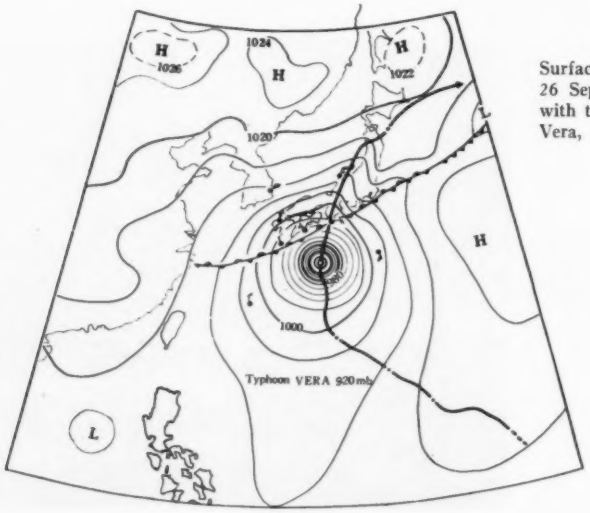
Flood over low-level lands along the shore of Ise Bay as a result of typhoon-induced storm tide. Photos courtesy Chubu Electric Power & Utility Co. Ltd.

Typhoon Vera and its Induced Storm Tide

H. ARAKAWA, *Meteorological Research Institute, Tokyo*

TYPHOON Vera, called Isewan Taifu or literally Ise Bay Typhoon by the Japanese, struck central Japan in the late afternoon of 26 September 1959 and caused the most severe weather disaster in Japanese history. An official police survey, made in December 1959, showed that the death toll credited to Typhoon Vera amounted to 4,696 persons with 355 more still missing. Over 1.6 millions were left homeless. Since the storm produced one of the most devastating storm tides in history, Vera has been subjected to intense study by Japanese and American meteorologists.

The depression from which Typhoon Vera originated first appeared on 20 September as a tropical depression about 280 nautical miles to the southeast of Saipan, Marianas. Moving north-northwest, it deepened and strengthened, and reached tropical storm intensity



Surface map for 0000Z, 26 September 1959, along with the path of Typhoon Vera, 20–27 September 1959.

by 1800Z on the 21st, at which time it had reached a position 150 nautical miles east-northeast of Saipan.

Moving northwest, storm Vera increased in intensity, and it was upgraded to a typhoon at 1800Z on the 22nd, when the center was at 17.3°N and 144.8°E.

From the 22nd through the 24th, Typhoon Vera moved to northwest. At 0600Z on the 23rd, U. S. observer aboard a weather reconnaissance WB-50 aircraft measured its sea level eye pressure at 896 mb/26.46", a maximum surface wind of 175 knots at 19.0°N and 142.9°E in its southeast quadrant, and the 700-mb height within its eye at 7,100 feet. Typhoon Vera had reached this maximum intensity within twelve hours after becoming a typhoon.

Photographic mosaic of the eye, taken at 0320Z on the 24th by the U-2 jet aircraft, as well as the WB-50 penetration report at 0200Z, shows that the eye did not retain a well-defined eye. Several missions, both research and reconnaissance, revealed a quite interesting property of this storm that Typhoon Vera was a variable-strength storm, and its eye alternated between an ill-defined and a well-defined one.

Around 1400Z on the 24th, Typhoon Vera began to veer from its northwest heading to north-northwest at the speed of about 18 knots. On 26 September, Typhoon Vera in its movement veered further to a north-northeast heading, accelerating in speed to 35 knots.

Sometime past 0900Z (or 1800 JCT) on the 26th, its center crossed the Japanese coast just west of Shionomisaki, Wakayama Prefecture. It then passed through Mie, Aichi, Gifu and Toyama Prefectures in Central Japan as shown in figure 1.

Leaving Honshu at about 1530Z just north of Toyama, Typhoon Vera then went into the Sea of Japan and turned to a more easterly direction. At about 2300Z it swept over northern Honshu at about 40° N, decreasing in strength, and then went out over the North Pacific south of the Kurile Archipelago, becoming an extra-tropical cyclone.

The average surface wind speed for a ten-minute period at Nagoya reached 81 mph

The path of Vera across Honshu Island. Note Ise Bay in central foreground just east of track.

from south-southeast at 2200 JCT with peak gusts up to 102 mph at 2125 JCT. The average surface wind speed at Irako weather station reached 102 mph from the south at 2045 JCT with peak gusts to 124 mph at 2121 JCT. The weather observer at Shionomisaki measured his lowest sea level pressure of 929.5 mb/27.45″ at 1813 JCT.

The amount of precipitation was also enormous due mostly to the upglide effect of overriding air accompanying a poleward-retreating warm front well in advance of the typhoon, and not exclusively to the circulation of the typhoon itself. Flash floods were reported at many places.

Cities and villages along the shore of Ise Bay received the full fury of Typhoon Vera and were almost completely destroyed by the typhoon-induced storm tide. The storm tide is defined as the difference between the observed and predicted sea levels. It was greatest at Nagoya, situated at the head of the V-shaped Ise Bay, where the surging water attained a height of 11.7 feet at 2135 JCT!

Total damage from Vera will never be known, but it is estimated to far exceed $1 billion.

An account of Typhoon Vera has been made part of a documental film on typhoons. The film has been made as educational material for Japanese schools. It was produced by the Toei Educational Film Company, Ltd., under partial sponsorship of the U. S. Weather Bureau, National Hurricane Research Project.

Flood along low-level lands on Ise Bay.

Destroyed dike along the shore of Handa City, Aichi Prefecture.

Nova Scotia's Record Snowstorm on 2-3 February 1960

R. V. DEXTER, *Dominion Public Weather Office, Halifax, N. S.*

After the storm—unused cars. *Halifax Chronicle-Herald* photo.

THE SNOW

IT began on Tuesday, February 2nd, in extreme western Nova Scotia, but it is difficult to say exactly when. Light snow with a mixture of drizzle and freezing drizzle had been falling in nearly all of the Maritime Provinces since late Monday morning, but no large amounts were accumulating. In fact, very few communities received as much as an inch of snow even after twelve hours of precipitation.

Yarmouth, however, had reported no snow through Monday night and, in retrospect, the snow that began there about 0900 Tuesday morning might have been the first of the big storm. Be that as it may, the character of the snowfall had altered in western Nova Scotia by late Tuesday evening, and Yarmouth reported a 6.5-inch fall in the six hours from 1400 to 2000.

During the same period, Halifax measured only 0.1″ of new snow. At 0200 Wednesday morning, Halifax reported 3.5″ and, by that time, the snow was piling up fast. Measurements are made at six-hour intervals only, making it difficult to estimate the maximum rate of fall, but for five of the six hours between 0200 and 0800, heavy snow was reported in the hourly observations, and the six-hour fall was 14″. This is an average of 2.33″ per hour. The rate of fall eased off slightly thereafter, but another 8.3″ fell between 0800 and 1400, and the storm ended at Halifax with a final 4.1″ from 1400 to 2200 Wednesday evening.

The total snowfall at Halifax was 30.3″, of which 29.9″ fell in twenty-four hours. This established two new records for the city. The previous heaviest snowfall in twenty-four hours was 24.0″ that fell on 30 January 1894, and that same storm also produced the previous greatest total for any one storm, with a fall of 25.2″ from beginning to end. Even "The Year of the Deep Snow" could not produce records to equal these. Two storms that winter produced snow on six of the last seven days of January 1905, but the total was only 26.4″, well below this year's 30.3″ in a day-and-one-half. The records quoted above all refer to downtown Halifax. The 1960 snow was even heavier in the suburbs where Spruce Hill Lake measured 36.0″ and Chain Lake recorded the heaviest snowfall with a total of 38.5″ for the storm as a whole.

The snow was wet and heavy. The temperature at Halifax was typical of most of western Nova Scotia during the storm, and almost all the snow came down with the mercury hovering between a maximum of 33° F and minimum of 31° F. High winds accompanied the snowfall, blowing consistently from the northeast with average hourly speeds ranging from 30 to 39 mph during the period of heaviest snowfall. The water content of the snow made it sufficiently heavy and sticky that there was less drifting than might have

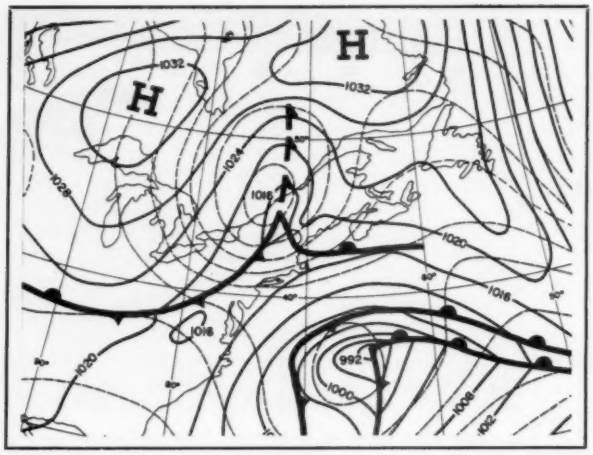


FIG. 1. Composite weather map, 2000 Atlantic Standard Time, 2 February 1960. Solid lines are isobars for surface map; dashed lines contours for 500-mb surface (approx. 20,000 ft.). Surface fronts are shown.

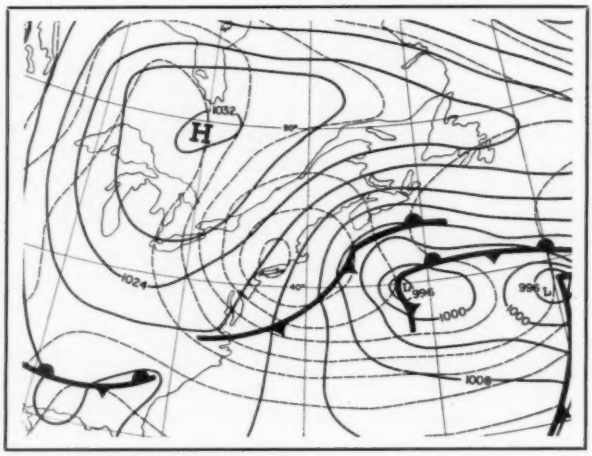


FIG. 2. Composite weather map, 2000 AST, 3 February 1960.

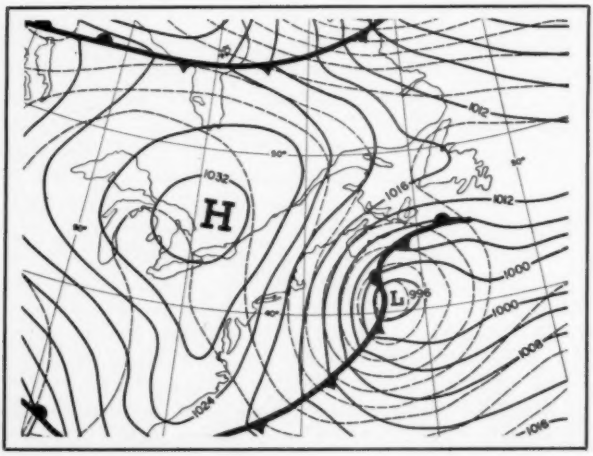


FIG. 3. Composite weather map, 2000 AST, 4 February 1960.

been expected. However, the falling snow was deposited unevenly at the whim of the wind gusts, and the snow accumulated most rapidly around and over bushes, cars, etc. The high winds kept excessive snow loads from building-up on trees and wires in exposed locations, but sheltered valleys were vulnerable to this hazard.

The storm was so severe that it was bound to disrupt surface transportation. The insidious way it began, by taking over from a much lighter snowfall, lured cars, trucks, and busses onto the streets and roads. They soon got hopelessly stuck, and this added to the difficulties of the snow-clearing crews. With heavy wet snow accumulating at 2.33" per hour on the average and at least half again as fast in those sections especially favored by the play of the wind, all wheeled vehicles, except those specifically equipped for such conditions with four-wheel drive and tire chains, were unable to operate. By Wednesday afternoon, many a mound of snow concealed an abandoned car. It is reliably reported that a few inches of aerial was sufficient evidence of a snow-covered car for a policeman to leave a parking ticket fluttering from the aerial just above the snow. In another location, a sign on a snow bank stated "Car." The warning was necessary, because some of these hidden cars were slashed from end to end by passing ploughs.

It took several hours for most people to become convinced that the storm could really stop *all* transportation, but by the end of the day after the long struggle home on foot, the point was conceded. The main streets and roads were cleared first, and some semblance of public transportation was in operation by Thursday morning. Side streets and roads of secondary importance remained closed under nearly three feet of snow for several days. The bus that regularly runs from Halifax to Peggys Cove in the early evening and returns to Halifax the following morning was snowed in at Peggys from Tuesday night until Friday afternoon.

Although all the walking, wading, and crawling through the snow brought many flabby muscles to the point of collapse, the tremendous shovelling job helped to work out some of the stiffness in the days that followed. The only permanent damage was to trees and bushes in sheltered locations. Sufficient snow accumulated to break limbs from the pine trees and bend birch trees over until their tops were held fast to the ground for days.

THE SYNOPTIC SITUATION

Figures 1 to 3 show the surface analysis (continuous lines) and the 500-mb contours (broken lines) for 24-hour intervals from 02/0000Z to 04/0000Z, February 1960.

A review of the synoptic weather charts for the period preceding the storm helps to explain its insidious beginning. The low to the south of Nova Scotia was moving toward the east-northeast until it split on Tuesday evening, 2 February (03/0000Z). The easterly circulation of moist air around this low produced intermittent light snow mixed with drizzle and freezing drizzle. The low that was near Montreal at 02/0000Z was moving southeast and causing light snow as it came. It disappeared from the (surface) chart by 02/1200Z, but it was probably responsible for the snow that began at Yarmouth at 02/1200Z, and it may have helped to split the low south of Nova Scotia by 03/0000Z. At any rate, two definite (surface) centers were in evidence at this time, and the 500-mb low off the coast was reduced to the status of a trough extending east-southeast from the 500-mb low that had been associated with the Montreal surface low.

It is impossible to be certain as to which of the two centers at 03/0000Z was the primary center, and which was the secondary, but the western center was probably the primary one. The eastern center then moved very rapidly toward the east-northeast, but the western center circled northwestward and then south as the upper low moved by. Finally, the whole system retreated rapidly eastward.

In addition to the rather unusual motion of the low, and the unprecedented snowfall it produced, it is interesting to note a few peculiar features of this storm:

(1) Heavy precipitation is normally associated with tropical air being lifted over polar and arctic air. In this case, tropical air was well to the east and was not involved. Sable Island soundings indicated that maritime polar air (wet-bulb potential temperature from 10° to 12° C) was present between 700 mb and 500 mb throughout the storm, and it did not appear appreciably lower than 700 mb at any time.

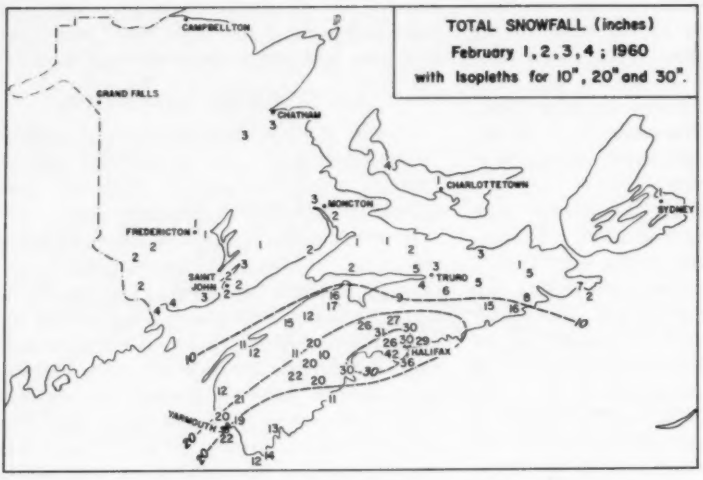


FIG. 4.

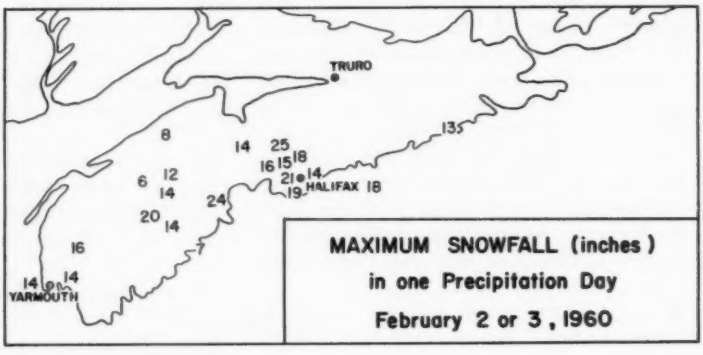


FIG. 5.

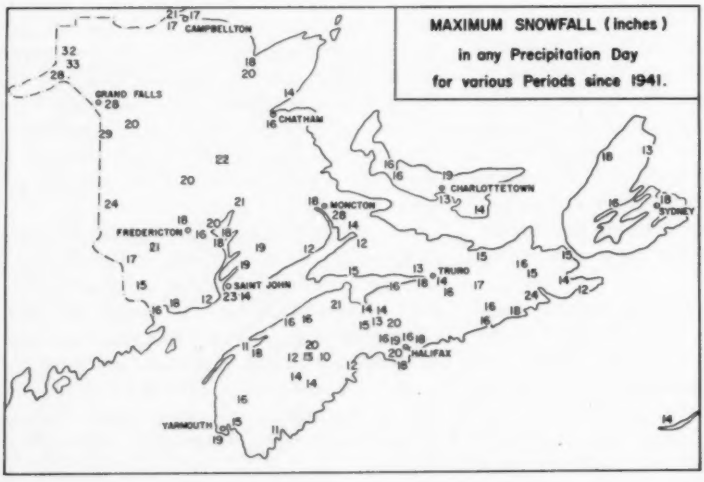


FIG. 6.

(2) Heavy precipitation is usually associated with a rapidly deepening low. This one had a central pressure between 990 mb /29.24″ and 994 mb/29.35″ throughout the period under consideration.

(3) A low usually gives its heaviest precipitation about the time it begins to occlude. If a secondary forms at the junction of the warm and cold fronts, the heaviest precipitation usually accompanies it while the older, primary center produces showery weather as it dies out. Although this is not a clear-cut case, the low on the polar front apparently had occluded by 03/0000Z, before the heavy snow began at Halifax. Perhaps the western low was a newly formed secondary. If so, this in itself was an unusual development.

(4) The distribution of the heaviest snowfalls in Nova Scotia is interesting. Figure 4 shows the total fall at each reporting station for the first four days of February. The pattern is surprisingly similar to the fallout pattern from a nuclear explosion, with the center of the target area at Halifax. The heaviest snowfall was not recorded by places closest to the center of low pressure, but it lay in a curved band from 100 to 150 miles to the north of the center. The edge of the storm was even sharper than Figure 4 indicates. When the light snowfall that preceded this storm is eliminated from the four-day totals, we find that the storm itself produced no snow at all in New Brunswick and Prince Edward Island, and only a very little on Cape Breton Island.

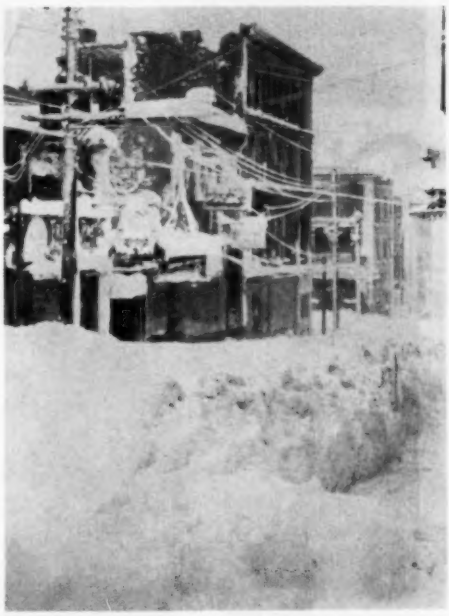
SOME COMPARATIVE STATISTICS

Not only may statistics be dull, but they often are in the wrong form for the purpose desired. Snowfall data are not exceptions. We are interested in knowing the greatest snowfall ever recorded in any twenty-four hour period at each station. Except for Halifax, our records show only the greatest fall ever recorded in the particular twenty-four hour period (known as the precipitation day) from 1200Z to 1200Z of the following day (0800 to 0800 AST). Figure 6 shows the maximum snowfall on record since 1941 for any precipitation day, and Figure 6 shows the maximum for a precipitation day during this storm (2–3 Feb. 1960). New records were established in several localities, but none of them approached the 32″ and 33″ recorded in a 1952 precipitation day at Summit Depot and Green River in northwestern New Brunswick. However, inspection of the records for the days preceding and following these heavy New Brunswick snowfalls reveals that the storm was confined almost entirely to the precipitation day. It is possible, then, that considerable searching might establish Chain Lake's 38.5 inches as the heaviest snowfall ever recorded in one storm in the Maritimes.

In spite of the fact that Halifax received 24″ in another snowstorm exactly five weeks later, some old-timers are still unconvinced that winters are as bad as they used to be. Meteorologists and most Haligonians are satisfied to let the new record stand. If, indeed, heavier snowfalls occurred in the past, and interesting as such storms may be, most of us agree with the Halifax editor who said, "Enough is enough."

Acknowledgment

Most of the statistics used in this article were supplied by the Climatology Division at Meteorological Headquarters. Without their assistance, the paper would not have been attempted.



A downtown street in Halifax with snow still falling. *Halifax Chronicle-Herald* photo.

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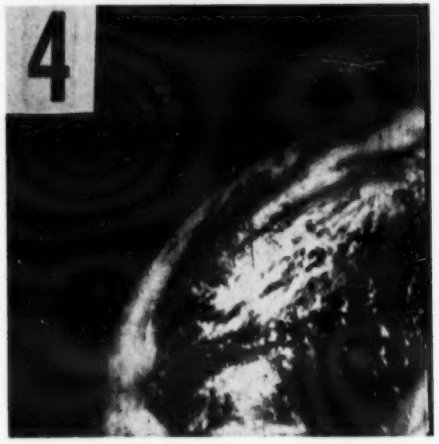
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Tiros I Concludes Mission; Tiros II Readied

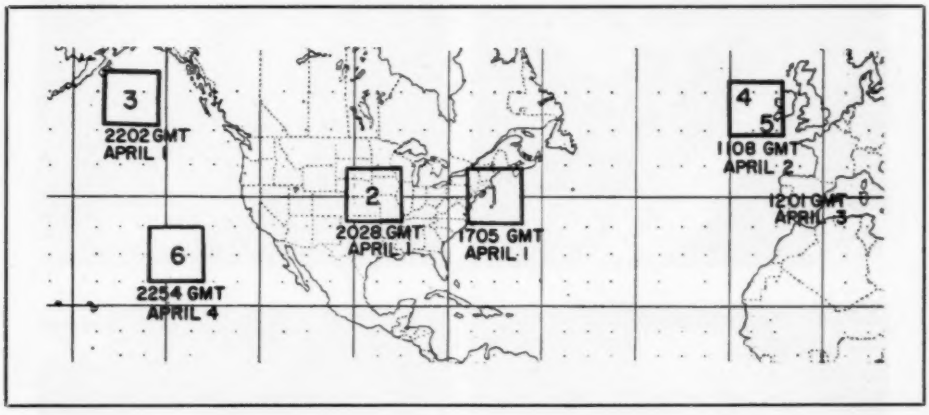
TIROS I, the first weather-eye satellite, has ended its useful life in space after transmitting about 23,000 photographs of cloud formations back to earth. The National Aeronautics and Space Administration announced on 1 July that it was ceasing efforts to interrograte Tiros after orbit 1302. The wide-angle camera and all telemetry had ceased to function, though the tracking beacon continued to operate.

From its launching on 1 April to 17 June, a period of 78 days, the cameras of Tiros scanned cloud formations from 50°N to 50°S, and at command transmitted photographs of atmospheric disturbances. About 200 hours of camera time were transmitted. The average distance from earth was about 450 miles.

Scientists of the U. S. Weather Bureau and other cooperating meteorological agencies will be analyzing Tiros data for many months to come. Chief Francis W. Reichelderfer said that the "spectacular operation of Tiros I had opened a new era in weather surveillance." With the photos coming back at the rate of 4,000 per week, the Bureau was swamped and asked Congress for an emergency appropriation of $36,000 so that the pictures could be properly classified and indexed.

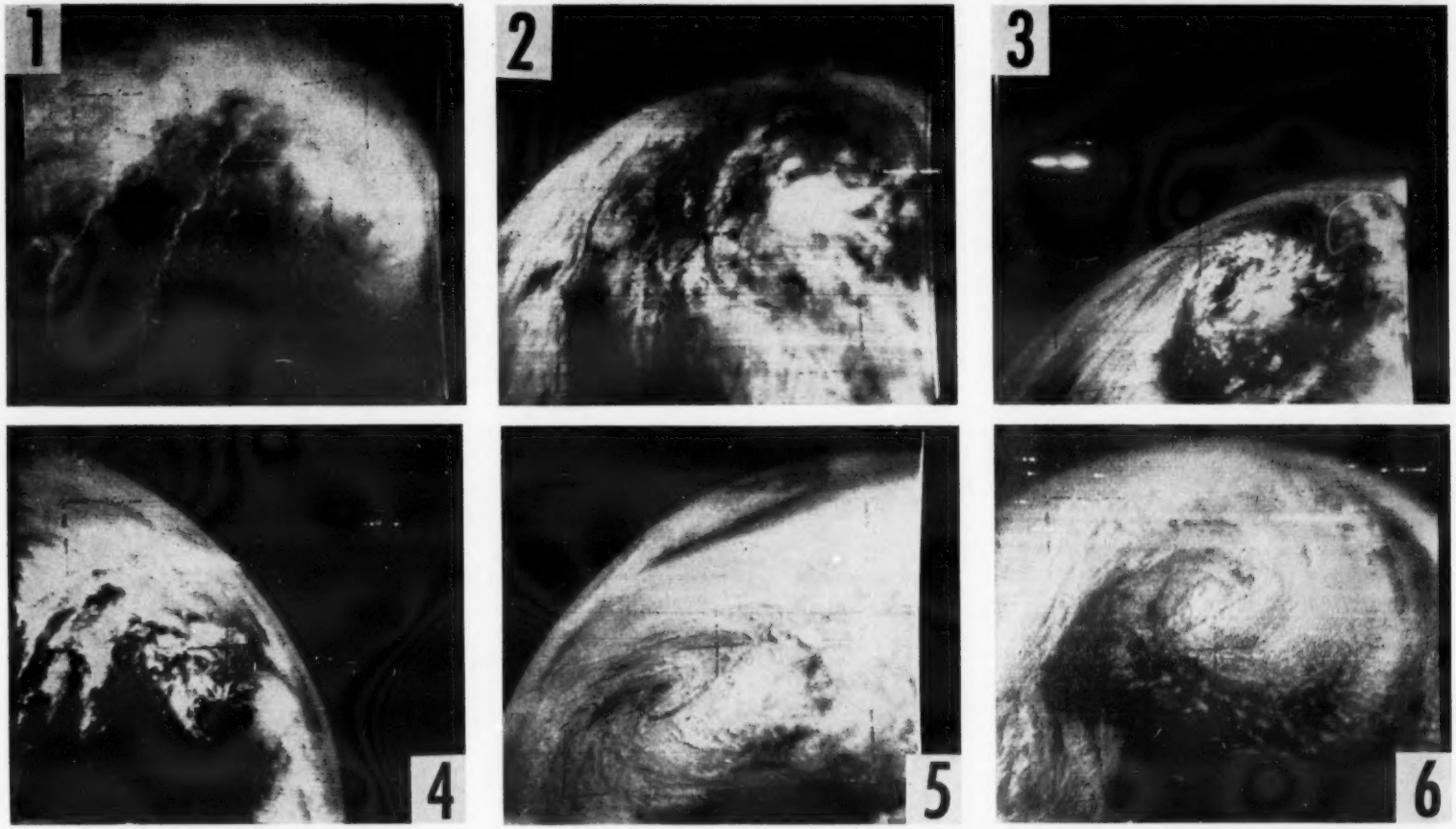
The results of the first analyses of the data have been summarized by Dr. Sigmund Fritz and Dr. Harry Wexler of the United States Weather Bureau.[1] "Tiros has revealed a large degree of organization in the cloud sys-

[1] S. Fritz and H. Wexler. Cloud Pictures from Satellite Tiros I. *Monthly Weather Review*, 88-3, March 1960, 79-87.



NORTHERN HEMISPHERE STORMS

1. Extratropical cyclone centered about 120 miles east of Cape Cod. About 1705Z, 1 April 1960.
2. Extratropical cyclone centered over southeastern Nebraska about 2028Z, 1 April 1960. Cold air mass behind front appears black to left of cloud associated with front.
3. Extratropical cyclone centered in the Gulf of Alaska about 2202Z, 1 April 1960.
4. Extratropical cyclone centered about 400 miles west of Ireland about 1108Z, 2 April 1960.
5. Same storm about 1201Z, 3 April 1960.
6. Extratropical cyclone centered about 800 miles west of southern California about 2254Z, 4 April 1960.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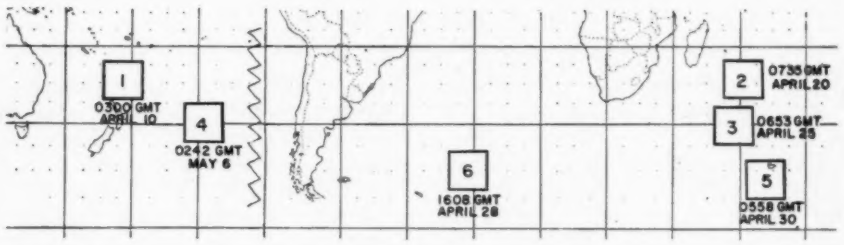
tems over much of the earth's surface. The most striking patterns are the spiral cloud formations associated with large storms, some as much as 1,500 miles in diameter, observed in such places as the United States, North Atlantic Ocean, North and South Pacific Oceans, and the Indian Ocean.

"It is well known from radar observations that hurricanes are characterized by bands of clouds which spiral inward around a storm center. Although some suggestions have been made that extratropical cyclones also contain bands, over oceans, now as a direct result of Tiros, we see that the spiral banded cloud structure also exists around well-developed extratropical storms. . . . But one of the significant results from Tiros is the clear indication that although storms have similarities, there may also be very marked differences. Study of the causes for these differences should reveal much about atmospheric processes and structures."

The success of Tiros I has put the meteorological satellite program well ahead of schedule. Tiros II is planned for the fall of 1960. The Air Weather Service of the U. S. Air Force and the U. S. Navy Weather Service, participants in the weather satellite program, and the U. S. Weather Bureau have been so encouraged by the quality and usefulness of the cloud photographs of Tiros I that plans are now being made to accelerate the transmission of satellite cloud analyses to principal military and Weather Bureau forecast centers for experimental use in analysis and forecasting.

Some exuberant press reporters have claimed that meteorological satellites "will revolutionize weather forecasting." Realistically, satellites promise to be revolutionary observing systems. While immediate improvement in weather analyses can be expected over the vast areas where few current observations are available, basic improvements in forecasting will evolve only from the careful study of cloud pictures, radiation data, and other measurements from Tiros I and subsequent satellites. Increased understanding of atmospheric processes resulting from these studies will contribute to the solution of the forecast problem.

(*Continued on page 180*)



(A large portion of the Pacific Ocean west of South America is omitted as indicated by the break on the map.)

SOUTHERN HEMISPHERE STORMS

1. Typhoon centered about 300 miles north of New Zealand about 0300Z, 10 April 1960. Also see front cover.
2. Extratropical cyclone in Indian Ocean about 0735Z, 20 April 1960.
3. Extratropical cyclone in Indian Ocean about 0653Z, 25 April 1960.
4. Extratropical cyclone in South Pacific Ocean about 0242Z, 6 May 1960.
5. Extratropical cyclone in Indian Ocean about 0558Z, 30 April 1960.
6. Extratropical cyclone in South Atlantic Ocean about 1608Z, 28 April 1960.

Byrd Station in September 1957, showing the amount of snow drift and accumulation in the camp area during first eight months of operation. The radome is in the center, with the aurora tower partially obscured. Note precipitation gage and thermometer shelter in foreground. Photo by W. Morris.

Inside Antarctica No. 5—Byrd Station

WESLEY R. MORRIS AND NORMAN L. PETERS,
U. S. Weather Bureau

ON the broad, wind-swept snow plateau of Marie Byrd Land, at exactly 80° South and 120° West, lies the site of Byrd Station, the second United States post established for the U. S.-IGY program in the forbidding interior of Antarctica. Unlike the Amundsen-Scott Station at the South Pole, described in an earlier issue of *Weatherwise*, this camp was established and largely resupplied by huge tractor trains operating from Little America V, over 600 miles away on the edge of the Ross Ice Shelf.

Attempts to reach the Byrd Station site in early 1956 were frustrated by severe weather conditions and equipment difficulties, with that summer's operations ending soon after a tragic accident in which a D-8 tractor plunged into an 80-foot crevasse, with its driver, Max Kiel, losing his life. The following summer season the reorganized trail reconnaissance party, composed of U. S. Navy personnel supported by Army Transportation Corps trail experts and assisted with supply drops from aircraft of the Navy's VX-6 squadron, renewed the attempts to establish Byrd Station. This time the long trail from Little America to Byrd was successfully negotiated, and the first men reached 80° S, 120° W on 23 December 1956, followed on 9 January 1957 by the first scientific personnel including meteorologist Wesley R. Morris. Immediately upon the latter's arrival, surface meteorological observations were begun, and regular upper-air rawinsonde observations started on 22 March 1957.

One reason for the choice of Byrd Station's location was the desire to investigate the puzzling atmospheric pressure surges which occur in West Antarctica. These surges, first noted and described by G. C. Simpson, the meteorologist of the British Antarctic Expedition of 1910–1913, were thought to originate at

about 80° S and 120° W and move northwestward across the Ross Ice Shelf. Before the International Geophysical Year effort, Antarctic data were not sufficient to determine the extent of and physical reasons for these pressure surges, but the accumulation of additional data begun with the IGY and continuing at the present time may shed further light on this problem.

After Byrd Station had been established, it was determined through seismic soundings that the relatively flat snow surface upon which the camp rests is the top of an 8-thousand-foot-thick layer of ice, although the camp is only about 5 thousand feet above sea level. The station lies near the track of cyclones which move onto the polar plateau from the Ross Sea and the Weddell Sea, so that storms along these paths bring intrusions of relatively warm maritime air, giving rise to stronger winds, heavier precipitation, and greater temperature fluctuations than might otherwise be expected at a location so deep in the interior of the Antarctic.

Because of the relatively strong winds and frequent blizzards, drifting and accumulation of snow in the camp area created additional problems for the meteorological program. At the end of 1958 the radome, housing the detection equipment used for upper-air soundings, had to be moved from the roof of one of the original buildings to a specially constructed tower, because of excessive drift around its original location. The drifting also necessitated frequent clearing of snow from the overhead release doors of the inflation shelter before release of the rawinsonde balloons; snow accumulation also made necessary the digging out and repositioning of outside equipment such as the instrument shelter, ceiling light projector, radiation instruments, and precipitation gauge.

The gathering of meteorological data which began in 1957 continued in 1958 under meteorologist Norman Peters and in 1959 under Bernard Weiss. During 1960 Mr. L. Aldaz, formerly of Mt. Washington Observatory, is in charge of the Byrd Station meteorological program.

Table I presents some of the surface observational data from the first three years of observations. The large fluctuations in mean temperature observed from year to year for the same month are particularly striking. In August 1957 the mean temperature was −19.8° F, the warmest of any of the seven months from March to September; in August 1958, the mean temperature was −44.0° F, the coldest month of that year. (In 1959, the mean August temperature of −38.8° F was again much lower than in 1957.) The warmth of the 1957 August is related to the surface circulation regime of that month, which saw many depressions, with their accompanying warm maritime air, moving from the Ross Sea to the Weddell Sea along tracks across or very near to Byrd Station. In 1958 the storm tracks were well north of Byrd, so that cold plateau air dominated the area, a fact reflected in the low figure for precipitation in 1958 as compared with 1957. The regime of August 1959 was similar to that of 1958. On a day-to-day basis the temperatures of August 1957 also fluctuated rapidly; on the 29th the temperature reached +8.3° F, and then dropped rapidly to a low of − 51.2° F on the 30th.

As can also be seen in the table, winds at Byrd Station, prevailingly from the north-northeast, average about 15 knots and reach gale force in nearly every month. Since it was observed that 20-knot winds (occurring over ⅔ of the time) were sufficient to start the snow drifting and that 30-knot winds (occurring about ⅓ of the time) resulted in blizzard conditions with near-zero visibility, the problem of drifting snow previously mentioned was worse at Byrd than at any other of the U. S. stations in the Antarctic.

At times there is evidence of an apparent katabatic flow at Byrd Station, particularly during the winter of 1958. Traverse parties have determined that there is a gentle rise of elevation to the north-northeast of the station and a fall to the southwest—a total drop of about 4 thousand feet in 300 miles; the prevailing winds are from north to northeast steadily throughout the year. During periods of clear weather there were times when a fairly brisk northerly wind (15–20 knots) decreased to almost calm about 1500 feet above the surface. It seems probable, with clear skies extending to the north, that the additional radiational cooling at the slightly higher elevation would be enough to cause a relatively colder layer of air near the surface which would then flow downslope southward as a gravity wind.

TABLE I

SELECTED METEOROLOGICAL DATA FOR BYRD STATION (80°S, 120°W) FOR 1957, 1958 AND 1959

	Temperature (°F)								
	Mean			Maximum			Minimum		
	'57	'58	'59	'57	'58	'59	'57	'58	'59
Jan.	+ 4.1	+13.3	− 0.8	+22.3	+23.7	+14.4	−21.3	−11.0	−17.7
Feb.	− 6.2	+ 5.2	− 1.8	+11.5	+19.4	+16.0	−34.8	− 3.6	−10.8
Mar.	−22.9	−18.4	−13.7	− 0.9	+ 7.9	+ 7.9	−50.1	−53.1	−44.0
Apr.	−32.4	−23.4	−11.0	+ 0.1	+15.4	+19.0	−68.1	−65.4	−49.2
May	−32.4	−18.9	−28.5	+19.6	+12.0	+18.1	−66.5	−66.6	−65.9
June	−28.3	−41.4	−27.0	+ 3.6	− 3.6	− 5.1	−70.4	−75.5	−54.8
July	−41.3	−41.3	−29.9	− 5.1	+13.5	+ 7.2	−69.9	−81.8	−66.3
Aug.	−19.8	−44.0	−37.8	+ 8.2	+ 0.9	− 4.7	−51.3	−80.0	−70.1
Sep.	−23.1	−40.2	−32.4	+ 1.4	− 6.0	− 2.6	−61.4	−65.0	−64.5
Oct.	−15.0	−22.2	−30.1	+11.8	+ 5.0	− 2.9	−54.8	−49.2	−59.1
Nov.	− 5.1	− 5.6	− 8.7	+24.1	+10.4	+13.8	−28.5	−28.1	−38.9
Dec.	+10.2	+ 1.0	+ 5.2	+24.1	+27.1	+17.1	−13.4	−21.8	− 9.0
Year	−17.7	−19.7	−18.0	+24.1	+27.1	+19.0	−70.4	−81.8	−70.1

TABLE I—*Continued*

	Wind			Fastest mile (MPH)			Precipitation		
	Prevailing dir. and speed (knots)						Water equivalent (inches)		
	'57	'58	'59	'57	'58	'59	'57	'58	'59
Jan.	N 10.5	NNE 13.1	NNE 12.0	28	32	36	1.24	.43	.06
Feb.	N 12.5	NNE 18.7	N 13.6	31	58	40	.77	T	.39
Mar.	NE 17.2	N 14.0	NNE 15.7	42	M	53	.86	.08	.03
Apr.	NNE 17.3	NNE 14.9	N 14.3	43	52	52	.72	.29	.14
May	NNE 16.5	NNE 19.0	NE 15.5	34	61	59	.96	.21	.13
June	N 15.5	N 12.3	NNE 17.1	47	44	60	1.97	.01	.12
July	NNE 19.0	N 15.7	N 16.3	45	63	67	2.73	.03	.10
Aug.	N 23.5	NNE 15.9	NNE 18.6	62	61	59	1.50	T	.12
Sep.	NE 22.5	NNE 20.0	NE 18.4	46	58	63	2.79	T	.09
Oct.	N 15.0	NNE 18.6	NE 14.9	44	52	45	3.24	.03	T
Nov.	NE 16.5	NNE 17.1	NNE 14.3	42	58	41	.05	T	M
Dec.	N 13.4	NNE 13.3	NE 11.5	50	40	36	.05	.65	.03
Year	N 16.6	NNE 16.1	NNE 15.2	62	63	67	16.88	1.75	1.21

Some interesting static electricity effects were observed at Byrd Station when blizzard conditions occurred at temperatures lower than about −30° F. At such times a high static electricity charge would build up on buildings and guy wires, with brilliant blue-white arcing visible during the dark period. This static would sometimes seriously impair radio communications, and also caused some concern to those of us working with the inflammable hydrogen used to inflate the radiosonde balloons, although luckily no mishaps occurred.

Extremely brilliant optical phenomena were also observed at Byrd Station, with ice crystals at low levels accounting for many of the

displays. Double halos and parhelia were common, and both tangential and circumzenithal arcs occurred frequently. One of the most interesting of displays came in May 1958, when a combination of ice crystals aloft and a water droplet fog to the south caused a bright halo around the full moon, a circumzenithal arc and a moon bow to the south which was intersected by the arc. The winter sky was frequently brightened by brilliant displays of auroras, the arcs, draperies, and streamers of which were sometimes beautifully colored.

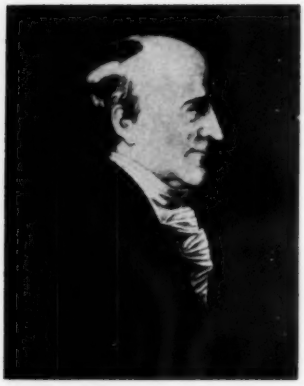
The upper-air program at Byrd experienced the usual Antarctic problem of premature balloon breakage during the polar night with its very low upper-air temperatures. During the winter soundings only infrequently reached above the 50-millibar level, despite the diesel oil conditioning of the balloons and the introduction of a steam condenser to remove excess water vapor from the hydrogen used to fill the balloons. The lowest temperature recorded on any of the upper-air soundings during the first two years was −93° C (−135° F) on 20 July 1958. In winter, particularly in July and early August, the tropopause would weaken or even disappear entirely, but with the return of the sun the tropopause became easily identifiable, usually between 300 and 200 millibars. The pattern of rapid spring stratospheric warming noted at other Antarctic stations also prevailed at Byrd Station. At a height of about 12 miles above sea level (50 millibars pressure) temperatures in 1957 rose from −70° C (−94° F) in mid-October to −27° C (−17° F) by 6 November, an increase of over 75° F in less than a month. In 1958 the warming was similar, although slightly less pronounced, with temperatures rising at the same level from −70° C in mid-October to −30° C by 10 November.

Our camp at Byrd Station consisted of seven buildings besides a radome and an aurora tower, and the total camp complement was normally about 24 men, half of whom were Navy support personnel and half civilian scientists. While our location, with its combination of low temperatures, strong winds, and frequent blizzards, had perhaps the most severe weather conditions of any of the U. S. Antarctic stations, nevertheless, morale remained uniformly high in the rather cramped living and working area throughout the year. While those of us at Byrd felt our year of isolated polar living to have been an interesting and worthwhile experience, both personally and scientifically, we still welcomed the appearance of aircraft bearing our replacements in November, when we began the long journey home and our year at Byrd Station became just a memory.

Aurora draperies over Byrd Station, 20 August 1959. The radome is visible in the lower left, while planet Jupiter shines brightly in the upper right. Photo by B. Weiss.

Acknowledgment

The authors wish to express their appreciation, and to thank sincerely Mr. William S. Weyant, Senior Meteorologist at Little America in 1958, for his valuable assistance in combining the material of the two original manuscripts from which the present article is composed.



Josiah Meigs, Pioneer Weatherman

HORACE S. CARTER,

Weather Bureau State Climatologist and Research Associate, Agricultural Engineering Dept., University of Georgia, Athens

ONE of the earliest weather records to be kept in the interior of the Deep South was made at Athens, Georgia, by the first professor of the University of Georgia. Josiah Meigs, a native of Connecticut and graduate of Yale, had been appointed by the Board of Trustees on 28 November 1800. Professor Meigs arrived in Athens during the spring or early summer of 1801; and on 16 June of that year was also appointed President of the University, a position he held until August 1810. The University had been chartered in 1785, but no classes were held until 1801.

Professor Meigs had a keen interest in weather and was apparently not in Athens very long before he began keeping a systematic record of daily weather conditions. We have been unable, so far, to locate any of his manuscript records; but, in an article in the Augusta *Georgia Chronicle* of 1 February 1806, he gives a rather complete summary of his observations for the year 1805. This summary includes monthly and annual mean temperatures, highest and lowest temperatures during the year, and the dates of last spring and first autumn frosts. Also given is a count of daily wind directions to eight points of the compass, and a three-year summary of clear, cloudy, and rainy days, indicating that daily records were kept from at least the beginning of 1803.

Professor Meigs states: "The height of the mercury in Farenheit's Thermometer was noted at morning, noon, and evening, each day. Three daily observations were made of the weather and one of the winds." In describing the exposure of his instruments, he has this to say: "The Thermometer was in the open air on the north side of a house, and about ten feet above the surface of the Earth. . . . By a thermometer kept in an open arbour of the same house, the mercury was generally, in summer, at noon, 8 or 10 degrees lower than the foregoing."

Professor Meigs' interest in weather extended over a period of many years, possibly throughout his adult lifetime. He practiced law in Bermuda from 1789 to 1794 and it is known that he made regular observations of the weather during at least a part of this time. However, his enthusiasm and efforts were not always confined to personally recording the weather. He spent the last eight years of his life (1814–1822) in Washington as Commissioner of the General Land Office; and, during this time, made some attempt to persuade Congress to establish a National weather service. In a letter dated 1 February 1817, to a friend, he writes as follows:

> . . . I, yesterday, suggested in a note to an influential member of Congress, whether a Resolution might not pass, authorizing the President of U. S. to cause Meteorological Registers to be kept at each of the Land Offices of the U. S., under the direction of the Commr. of the G. L. Office, and that the meteorological observations should be returned monthly to the G. L. Office with their Official Returns. . . . You will see

with a glance of your bright mind that something very clever might be made of this. If my plan be adopted, and the Registers be furnished with the requisite Instruments for Temperature, Pressure, Rain, Wind, &c., the expense of which would be a mere trifle compared to what YOU and I, at least, think the value of the object, we may in a course of years know more than we shall be able to know on any other plan. I shall prefer the Centigrade Thermr.

In another letter to the same friend, dated 13 June 1817, he writes:

> . . . I am glad you and Dr. Mitchell and other intelligent men are pleased with my effort to obtain Meteorological information. It is certainly a good plan, and I shall persevere in it, until it shall have become a matter of course. I mentioned the matter to some influential members of the National Legislature, but they were so deeply occupied with more important subjects that nothing was done. I shall however pursue it next winter; without some system of this kind, our Country may be occupied for ages, and we the people of the U. S. be as ignorant on this subject as the Kickapoos now are, who have occupied a part of it for ages past.

Although he was unsuccessful in his efforts to get the Government to sponsor or authorize meteorological observations by the land offices, he did not give up his efforts to collect these records. On 29 April 1817, in a circular letter to the Registers of the Land Offices, he requested that regular observations be taken and forwarded to him at the end of each month. Forms, sent out with his letter, provided for the entry of temperature, wind, and weather at three daily observations—morning, 2 PM, and in the evening. There was also a space for entering miscellaneous observations. It was suggested that these might include the time of leafing and flowering of plants, the migration of birds north or south, the migration of fishes to or from the oceans, unusual rains, severe droughts, snowstorms, hail storms, hurricanes, tornadoes, earthquakes, and meteors.

His request was apparently favorably received by at least some of the Land Offices. Summaries that he prepared from their records appear periodically in newspapers during the next few years. Daily records for an entire year (July 1817–June 1818), at Chillicothe, Ohio, are reproduced on pages 16–23 of the Supplement to Volume XV of *Niles*

(*Continued on page 181*)

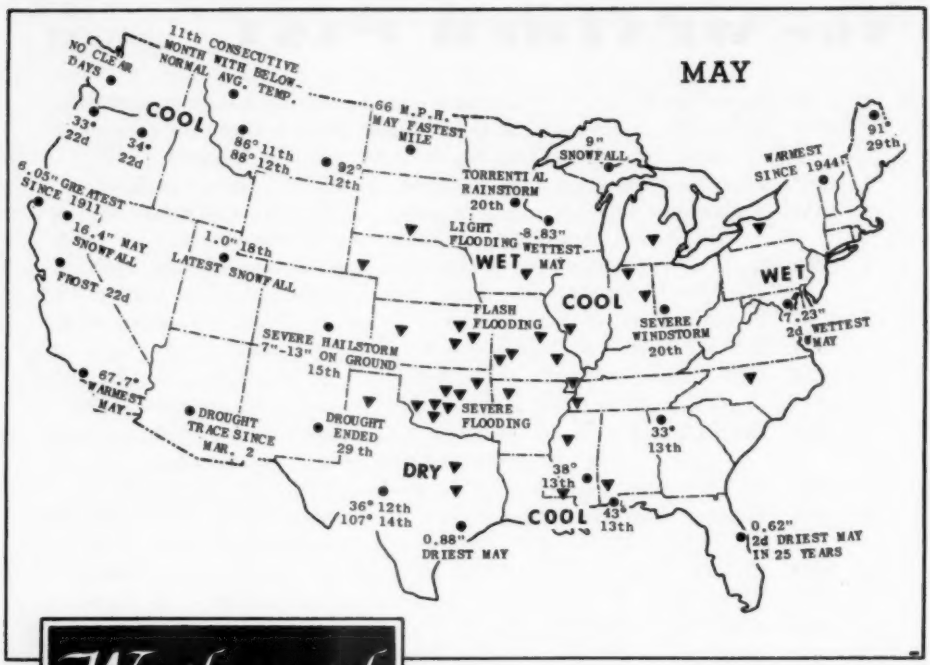
Old College at the University of Georgia, Athens. Design of the building was recommended by President Meigs from an earlier Yale building.

The WEATHER PAST / September

1	1955	Los Angeles: 110°, all-time maximum for any month.
2	1935	"Labor Day Hurricane" at Key West—small, intense storm produced lowest U. S. barometer of 26.35″—storm tide 15′—400 lost.
	1950	Mecca, Calif: 126°, highest ever for U. S. in September.
3	1821	Long Island Hurricane—landfall near Idlewild Airport—into SE Ct.
4	1939	"Once in a Hundred Year Rainstorm"—Wash., D. C. 4.40″ 2-hrs. (Zoo).
5		
6	1667	"Dreadful Hurry Cane" in Virginia did great damage, 12-day rain.
	1881	Famous Yellow Day in Northeast caused by forest fires in Michigan.
7	1881	NYC's hottest Sept. day: max. 100.2°, min. 74°—Washington 104°.
8	1769	Great coast hurricane swept North Carolina to New England.
	1869	Small hurricane crossed R. I. & Mass.—damage at Boston, 29.02″.
	1900	The Galveston Disaster—hurricane tide—city under 8–15′ water—6,000 perished—3,600 houses destroyed—damage $30 million.
9	1821	Tornado outbreak Mass-Vt-NH—large funnel swept Sunapee area.
	1921	Most intense US rainfall: 36.40″ (18), 38.20″ (24 hrs), Thrall, Tex.
10	1804	Great Gale of 1804 at Savannah & Charleston—Aaron Burr in eye.
11	1949	Helena, Mont: 7.5″ snow, earliest in 80 years, 22° on 12th.
	1954	Edna cut across Vineyard & Cape Cod—near 28.00″—23 killed.
12	1882	Hot, dry winds caused tree foliage to crumble in east Kansas.
13	1928	San Felipe, one of Puerto Rico's great hurricanes—149 mph.
14	1944	Great Atlantic Hurricane swept Cape Hatteras (27.97″)—sideswiped N. J. & Long Island—crossed SE Mass.—390 lost—$100 million.
15	1752	"The Great Hurricane" at Charleston—tide within 12″ of covering entire town—water fell 5′ in 10 min. with wind shift.
16	1913	San Francisco's hottest day—101.2° downtown.
	1928	San Felipe Hurricane struck Palm Beach—27.43″—enormous damage—floods around Lake Okeechobee drowned 1,836—1,870 injured.
17	1713	Charleston: Third great colonial hurricane eroded harbor shoreline.
18	1926	The Great Miami Hurricane—center passed over city (27.61″)—123 mph (5-min.), 138 (2-min.)—tide rose 11.7′—372 killed.
19	1947	Eye of great hurricane over N. Orleans—28.61″—51 lost—$110 million.
20	1845	Adirondack tornado—L. Ontario to Vermont—windfall ½ mile wide.
21	1938	Great New England Hurricane—crossed Long Island (Bellport 27.94″), west of N. Haven thru Mass. & Vt.—great floods—494 lost.
22		
23	1815	The Great September Gale in New England—equal stature, track just east of 1938—landfall Moriches, N. Y.—east of N. Haven.
24	1926	Riverside R.S. (Yellowstone Park), Mont: +9°, lowest for U. S. in Sept.
25	1939	El Cordonazo struck Southern California—45 lives—$2 million—greatest Sept. rainstorm by far: 5.42″ in 24 hours.
26	1950	Blue Sun & Moon over Northeast US caused by fires in B. Columbia.
27	1906	Pensacola-Mobile hurricane—28.84″—9.9′ tide—"worst since 1736."
	1936	Early heavy snow dropped 21.3″ at Denver Airport in 60-hour storm.
28	1836	First of three early 1836 snows: Hamilton, N. Y. 4″, Ashby, Mass. 2″.
29	1915	Hurricane hit SE Louisiana—gust 140 mph—28.11″—$13 million.
	1927	Out-of-season tornado killed 72 at St. Louis—path 2.5 m. long.
30	1835	Heavy snow on US-Canada border: N. Hatley, P.Q. 10″, Kilkenny, NH 6″.

The WEATHER PAST / October

1	1752	Second severe 1752 hurricane blew down Onslow Co. Courthouse, N. C.
	1837	H.M.S. Racer dismasted in Gulf—famous Racer's Hurricane then swept from Texas across Gulf States to Atlantic near Hatteras.
2	1867	Texas hurricane-storm tide—Galveston $1 million—Racer's path.
3	1841	The October Gale—Nantucket's worst—caught Cape Cod fishing fleet at sea, 57 lost from Truro—18″ snow near Middletown, Ct.
4	1869	Saxby's Storm—predicted a year ahead—great wind damage Maine & New Brunswick—high floods New England—12.35″ at Canton, Ct.
5	1786	Pumpkin Flood on Susquehanna & Delaware—Harrisburg record 22 ft.
	1917	Sentinel, Ariz: 116°, highest ever for U. S. in October.
6	1836	Second heavy 1836 early snow: Auburn, N. Y. 26″, Wilkesbarre, Pa. 11″.
7	1783	Charleston: "The Great Storm of 1783"—worst hurricane since 1752.
8	1871	Great Chicago Fire: 250 lost, $196 million loss—severe drought prepared scene—strong south-southwest wind blew fire across city.
9	1903	NYC's heaviest 24-hr rain 9.40″—flooded Passic Valley (NJ) 15″+.
10	1804	Famous Snow Hurricane—peculiar disturbance caused northerly gales N. J. to Maine—great snow west New England, 20″ Mass. & Vt.
11	1954	Chicago Deluge: 6.72″ in 48-hrs, unofficial 10″+—great river damage.
12	1836	Third heavy 1836 early snow: Bridgewater 18″, Madison 12″ in N. Y.
13	1846	Great Havana-Key West-Wash. D. C. Hurricane—major damage thruout.
14	1925	Okla: severe hail storm Garvin, Stephens, Comanche, Cos.—$750,000.
15	1954	Hazel roared inland Myrtle Beach, S. C. (28.47″—106 mph)—hurricane winds & great damage Va., Md., Pa.—$250 million.
16	1880	Early season blizzard struck east S. Dakota & south Minn.—railroads blocked—drifts remained till spring—very severe winter followed.
17	1910	Loop Hurricane off Florida—Sand Key 28.40″—125 mph est.
18	1930	Great snow lee L. Erie-Ontario—4′ deep just south of Buffalo.
19	1844	Famous Lower Lakes storm—SW hurricane for 5 hours blew lake waters into Buffalo—200 dead—Toronto barometer 28.86″.
20	1770	New England: "an exceeding great NE storm"—huge hurricane damage.
21	1492	Columbus made landfall San Salvador Island under clear skies—he met no true hurricanes on First Voyage, Sept. 1492–March 1493.
	1780	Solano's Storm prevented Spanish Admiral from attacking Pensacola.
	1929	Los Angeles: latest 100° reading ever recorded.
22	1766	Pensacola: ESE to WSW hurricane—only four ships rode it out.
23	1843	October snow Vermont (Newbury 12″) said to lay till next spring.
24	1785	Four-day rain put Merrimac in NH-Mass to greatest height then known.
	1878	Hurricane over Annapolis (28.82″)—Phila's worst—84 mph Cape May.
25	1840	Thompson, Ct: "a tedious snow storm fell a foot deep some places."
26	1859	New York City's earliest substantial snow—4″ fell.
27	1764	"Very remarkable storm of snow with high wind"—22″ Rutland, Mass.
	1843	Edwards, Miss: snow and sleet 34°, followed by frost & 33° on 28th.
28		
29	1693	Acomack Storm on Del-Mar-Va peninsula changed many rivers-harbors.
	1917	Soda Butte, Wyo: −33°, lowest ever for U. S. in October.
30	1844	Buffalo Barracks, N. Y: 30″ in 3-day storm—Fredonia 21″.
31	1899	Hurricane hit Myrtle Beach & Wilmington area in Carolinas.



Weatherwatch

Data by Office of Climatology, USWB.

A Circulation Break Between May and June

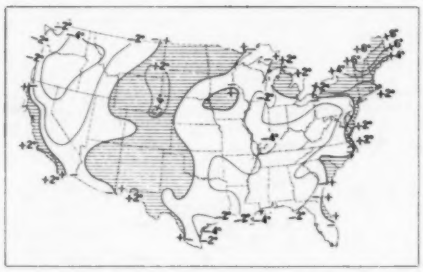
DAVID M. LUDLUM

Blocking of the normal northeasterly movement of storms across the continent provided the theme for the atmospheric circulation of May. The key to this will be found in the persistence of high pressure over northeastern Canada where surface barometric readings averaged as much as 7mb/.22" above normal for the month. On a majority of weather maps a vigorous anticyclone hovered over the chill expanses of Hudson Bay with a curving arm extending eastward over still snow-covered northern Quebec and southeastward to Labrador and Newfoundland. Directly to the south, over the Lower Lakes and Ohio Valley, was found an equally persistent low pressure vortex, trapped there by the encircling ridge of high pressure to the northeast.

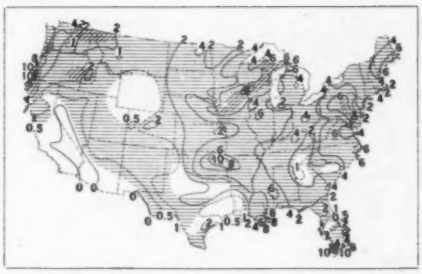
Below normal pressures were registered in all sections of the United States with the exception of California. With blocking a feature, it was a month of low westerly flow index—air moved north and south freely along the lines of the meridians, resulting in great temperature contrasts from section to section across the country and also marked changes from week to week as the axis of flow shifted eastward or westward. The precipitation pattern, too, as shown on the accompanying chart produced a varying patchwork of wet and dry areas.

The trend of May weather events can best be illustrated by following the courses of the month's major depressions across the mid-continent. On May 3rd a closed low pressure circulation (one with circular isobars, containing its own vortex circulation, and not directly connected to the polar areas) made an appearance on upper-air maps off the Oregon coast. It travelled eastward at a sluggish pace until reaching the Lower Lakes and Upper Ohio Valley region on the 8th where it became practically stationary, to remain in this area until the 14th when a slow eastward drift recommenced.

During the stationary period the circular low transformed its isobaric pattern into a pronounced north-south trough, an alignment which stimulated an extraordinary meridional flow at all levels. This brought extreme temperatures to each side of the trough: coldest for so-late-in-the-season to the Deep South and warmest for so-early-in-the-season to northern New England. Finally, after its two-weeks



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.



Total Precipitation in inches. USWB chart.

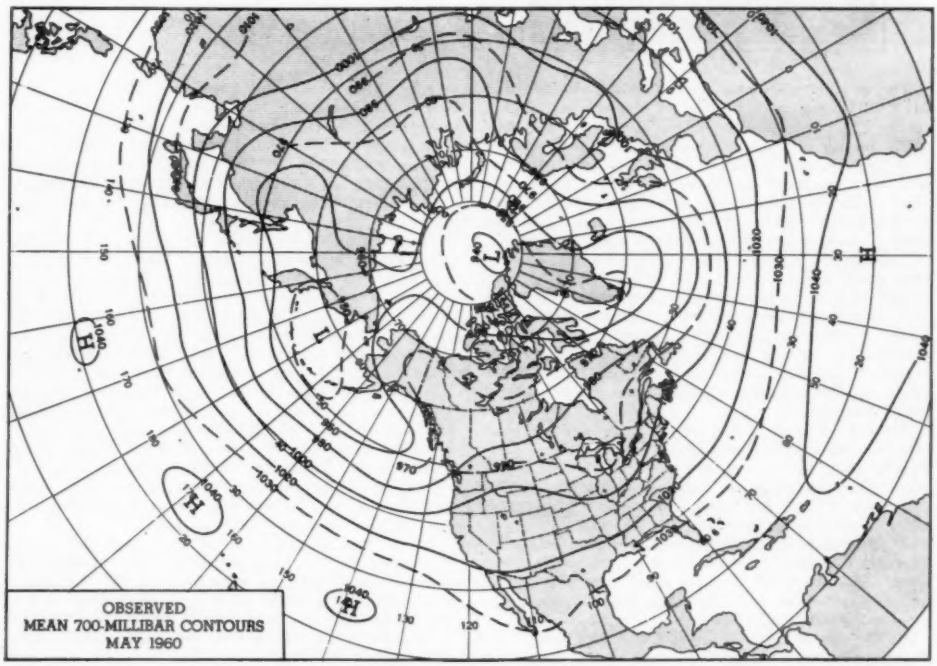
transcontinental journey, the upper low and its attendant cloudiness and precipitation passed off the New England coast on the 15th.

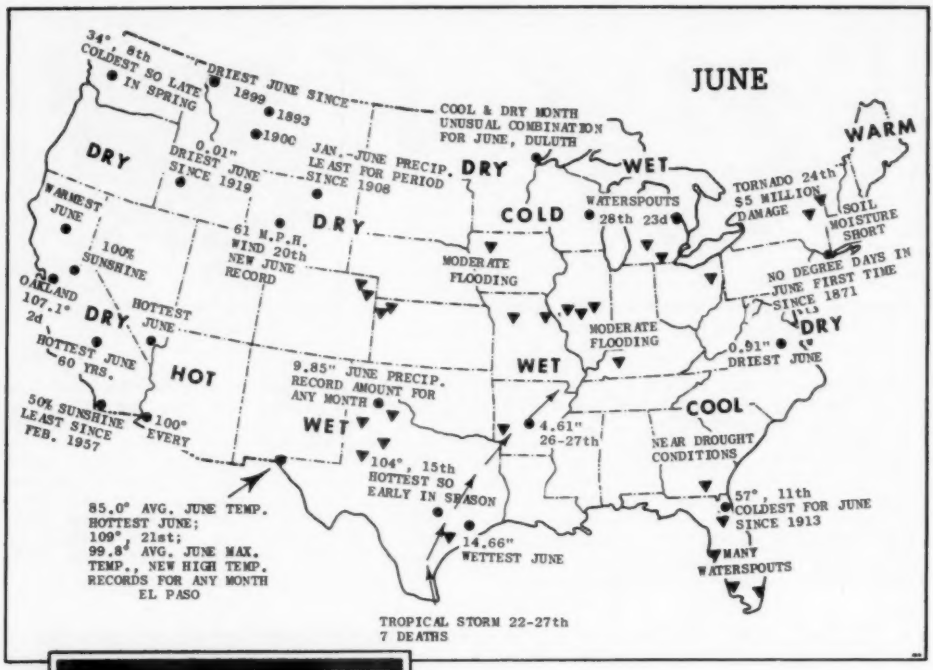
A similar, but less well-developed, low pressure feature held the stage from the 17th to the 25th and produced much the same type of weather. An upper-air trough entered the Pacific Northwest on the 17th and developed its own circulation over the northern Rockies on the 18th. This became a marked whirl over the central Plains by the 20th; then it drifted slowly northeastward across the Lower Lakes, flattened out over New York and New England, and passed off the coast on the 25th to end a prolonged unsettled period in the Lower Lakes and Northeast.

Soon after the above pressure feature moved eastward, another closed circulation developed along the Pacific Northwest coast on the 20th. Instead of moving eastward, it hovered off the Oregon-Washington coast for five days where it produced an unusual late May week of cold rain and cloudy

(*Continued on page 175*)

The upper-air map below shows the pattern of air flow for May at about 10,000 feet, on which the average weather largely depends. The contours lines represent the mean height of the 700 mb. pressure level. Figures are in tens of feet: 1020 = 10,200 ft., 980 = 9,800 ft., etc. Chart by Extended Forecast Section, USWB.





Weatherwatch

The weather map underwent a radical change from May to June as a high index of westerly circulation replaced the consistently low index flow of the previous month. Gone was the major blocking area over Quebec and Labrador where surface pressures had been as much as 7mb/.22″ above normal in May. Anticyclonic excess now lay southeast over Newfoundland and northwest over the Canadian Arctic. In-between lay a center of cyclonic activity.

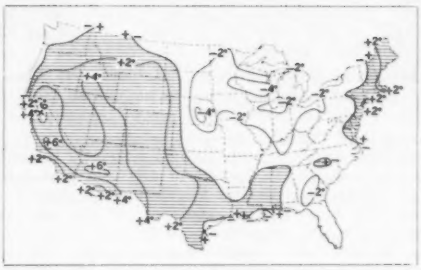
The upper-air charts showed a closed low circulation over Hudson Strait and Baffin Land with a trough in a mean June position extending southward and then south-southwestward through the Lower Lakes to the Louisiana Gulf coast. Hudson Bay now had a cyclonic flow to replace the anticyclonic regime of the previous 30 days, and this had a major effect on the weather of the upper Midwest and Great Lakes areas.

An ever greater range of pressure change took place off the Pacific Coast of the United States. The Pacific high, far to the west in May, pushed eastward closer to a normal summer position after the conclusion of the first week of June. Surface pressures showed an excess of 5mb/.16″ above normal just offshore in the same localities where the May averages had run a 5 mb deficit. As a result, very sunny and dry conditions prevailed over the Pacific and Plateau states to replace the unseasonable coolness and cloudiness of May.

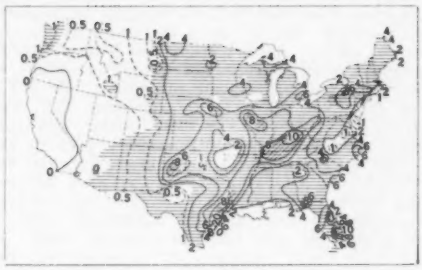
As the month of June opened, the first week featured the last of a series of eastward-moving vortices of the type which had made the May maps outstanding. From the 1st to the 4th a vigorous low pressure center moved across southern Canada. Thereafter, cyclonic activity shifted farther and farther northward. It was the Alberta type cyclone with a path across central Canada which dominated the weather in the mid-continent after the first week of June.

In the United States the streamlines of air flow were along the lines of latitude from west to east. Air of Pacific origin prevailed everywhere from the Rockies westward—the temperature departure maps show a large *much above* normal area covering most of the Southwest from California to central Texas. As the month progressed a lobe of the Pacific high extended inland over northern Mexico and then a sub-center of high pressure built up with its own anticyclonic circulation. The air masses were quickly transformed into tropical continental and a record-breaking heat wave was on. El Paso, Texas, stood almost under the center of this great mass of subsiding air. The previous absolute maximum temperature for any month was exceeded on four successive days from the 18th to 21st.

In contrast to the reign of heat and sun in the Southwest, farther to the east the cold conditions of May persisted through most of June as the region lay under the control of a cyclonic system whose main base now lay in Canada. In the rear of each movement of an Alberta type low, cold unstable polar air rushed southeastward, to maintain daytime



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.



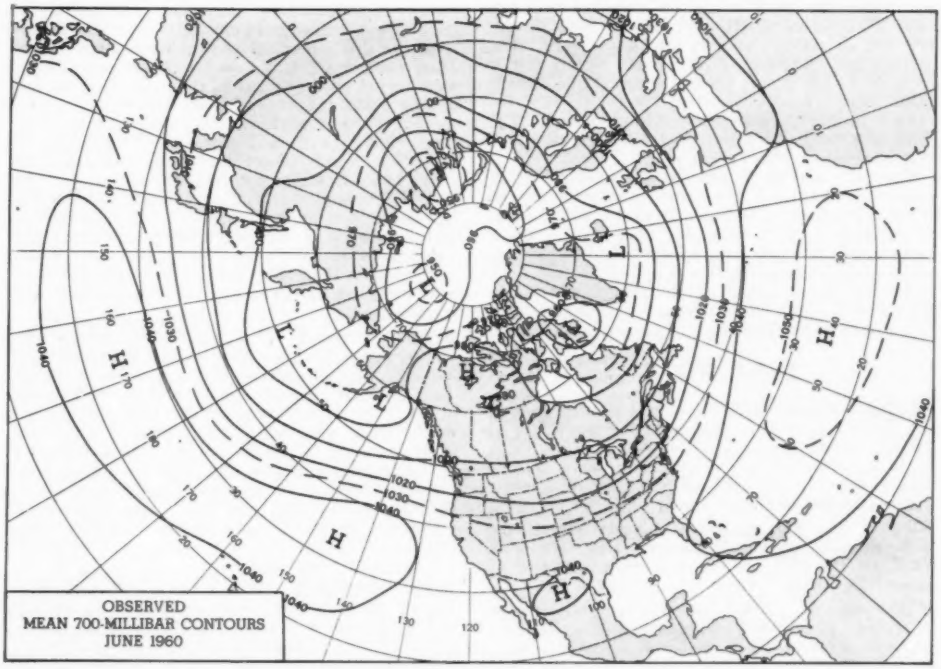
Total Precipitation in inches. USWB chart.

cloudiness and to permit rapid radiation at night. As a result, temperatures were *below* normal over a large area of the Midwest, Ohio and Tennessee valleys, and southeastward to the Atlantic Coast from Carolina to Florida. In a sizable area from South Dakota to Lake Michigan the mercury averaged *much below*.

The northeastern section of the country from North Carolina to Maine received a varying flow with alternate streams of tropical air and polar air prevailing in quick succession as frontal systems swept through. Temperatures averaged close to normal except in eastern New England where a more southerly flow tended to keep readings *above* normal.

SOUTHWEST HEAT—Even though June 1959 had set many new records for sustained heat in the Southwest, June 1960 outdid its predecessor. The combination of a deep thermal low over the Gulf of California area (which brought a southerly flow at the surface from the Mexican deserts) and a large upper-air anticyclone over northern Mexico and the southern U. S. border region (which contributed subsiding, warming air in vast quantities) produced the warmest June ever in some areas and the mercury hit new all-time peaks in others.

El Paso, Texas, had temperatures of 100° or more on every day from the 14th thru the 30th with the single exception of the 25th when a southeasterly stream kept the maximum to only 96°. On four consecutive days the mercury exceeded the previous absolute maximum at El Paso: 18th–21st, 108°, 108°, 108°, 109°. The 11 successive days with 100° or more was a new record.



The hot air penetrated into central Texas on the 15th when Waco had 104°, the warmest for so-early-in-the-season. But it was to the west that the real heat regime lay. Both Winslow and Yuma, Arizona, had their warmest Junes. At Yuma every day of the month had a maximum of at least 100°. The max. there was 115° and the minimum 70°. The interior of California also lay within the heat region. Bakersfield had its warmest June in the 60-year stretch of record there. Fresno had its 4th warmest. At Sacramento there was 100% of sunshine for only the second time since such records commenced in 1905, and the remarkable twist to this is that the only other time was in 1959! At Red Bluff, Calif., June was 0.4° warmer than any other June and only a trace of precipitation fell. At Medford, Oregon, the influence of the Pacific high is seen in the complete lack of measurable rain, only the 5th time of such an occurrence.

TROPICAL STORM—An area of showers and squalls developed in the Gulf of Mexico on 22–23 June. This disturbance moved inland south of Corpus Christi, Texas, early on the 24th, attended by gale force winds and torrential rains. The lowest pressure was at Alice (29.60″/1002.4mb). The low reading of 29.64″ at Corpus Christi came at 0300/24th. The highest wind gust of 68 mph was reported from the immediate coast. Moderate damage to signs, trees, and utility lines occurred in the Corpus Christi area.

The storm center pursued a leisurely course north-northeastward about 60 miles inland from the Texas coast, passing just east of Austin about 0100/26th. Along its immediate eastern flank the storm developed a remarkable rainfall pattern. Very heavy rains fell over a narrow belt near the coast. Port Lavaca, situated between Victoria and the Gulf, received the high total of 29.76″ from the four-day rain. The deluge at Houston set new rainfall records for all periods from two to seven days. The 48-hour rain there was 13.26″. Other reports ranged from 5″ to 15″ in the eastern sector of the storm's path. Severe flooding developed in the lower Colorado, Navidad, Lavaca, and Guadelupe Rivers. The rains ended in spectacular fashion a dry period which had extended back to February.

The very narrow breadth of the intense rainfall pattern accompanied the slow movement of the storm northward. The cities of Shreveport (3.22″), Little Rock (5.87″), Memphis (2.28″), and Cairo (4.30″), all received very substantial amounts, but locations 50 miles distant had only a light fall. The weak low which caused all the rain finally disappeared on the 29th when it merged with a cold front in a trough of low pressure in the lower Ohio Valley.

JUNE NOTES

Portland, Maine. This was a very pleasant month, the sunniest June since 1950, with the percentage of possible sunshine exceeding the average June value by 12%. Although rainfall was fairly heavy in some thunderstorms, these were well separated, and measurable rain fell on only 6 days.

Albany, N. Y. A severe tornado struck the Rotterdam-Schenectady-Niskayuna area at 1930, EDT, on the 24th and damages were estimated at around $5 million. There was no loss of life.

Richmond, Va. Driest June for the entire period of record. Total 0.54″ downtown, 0.91″ at airport; previous driest 0.99″ in 1950. Records date from 1871.

Atlanta, Ga. Temperatures fluctuated frequently in small plus or minus departures. With only 0.96″ rainfall in May and 1.26″ in June, soil moisture has become badly depleted.

Burlington, Iowa. June was cool and wet. One of the heaviest rains on record occurred on the 11th with two inches falling in about 20 minutes.

Amarillo, Texas. A tornado dipped down at Amarillo AFB and caused considerable property damage. An all-time record of 9.85″ for a monthly total rainfall was set this month, exceeding 9.76″ in June 1923 and 9.81″ in May 1951. There was considerable hail damage in the east part of the city on the 9th. The month closed out mild and dry and was ideal for wheat harvest.

Great Falls, Mont. This was the driest June ever recorded since 1893 when records commenced—only 0.52″ fell.

Williston, N. D. Good rainfall (5.22″) throughout the month made this the wettest June since 1953 when 5.62″ was recorded.

Kalispell, Mont. Snow fell at some places in the valley on the 21st. Snow fell on the surrounding mountains both on the 20th and 21st with snow remaining on the ground for several days down to an elevation of 1500′. Only 0.37″ precipitation fell, the least amount for any June since records commenced in 1899.

Long Beach, Calif. There were five consecutive days practically without sunshine early in the month that had the natives worried. Otherwise there was no unusual weather this month.

CANADIAN HIGHLIGHTS

The absence of an upper-level trough near the west coast of the United States and continued blocking action over Baffin Island in the northeast Arctic were the two important controlling features of the June, 1960, weather in Canada. The absence of the west coast trough resulted in a stronger than normal airflow across the western United States and southwestern Canada producing below normal temperatures in British Columbia. As the vigorous lows moved inland they deepened in the lee of the Rockies giving the northern and eastern sections of the Prairie Provinces much above normal rainfall. The blocking action in the northeast Arctic produced a high frequency of cyclonic activity near the Great Lakes resulting in considerable rainfall but farther east in the Atlantic Provinces there was a minimum of synoptic-scale storm activity and a pleasant month was the result.

British Columbia. June followed its normal pattern of unsettled weather throughout British Columbia. Cyclonic activity along the North Pacific coast produced generally above normal precipitation in northern B. C. while in the southern districts precipitation was only ⅓ to ½ normal. For the month as a whole Lytton was the warmest location in the province averaging 65°, while the highest temperature recorded in western Canada was 82° at Penticton. The wind record at Vancouver Airport was indicative of the northward shift of the storm track as a new low June average speed record of 6.5 mph was established.

Prairie Provinces. All but the southwestern portion of the Prairie Provinces experienced above normal precipitation in June. Regina with slightly in excess of 5″ reported the wettest June in 15 years, while the highest precipitation in western Canada

was reported from nearby Condie with 7.82″. Damaging hail storms occurred in central and northern Alberta on June 24th and 25th. Temperatures throughout the southern portions of the Prairie Provinces averaged about 2 degrees below normal.

Ontario-Quebec. The heaviest rainfall in eastern Canada during June occurred in the Lake Temis-Kaming region on the boundary of Ontario and Quebec. The greatest fall, 10.58″, was reported from Montreal River, Ont. Throughout this area and in the Georgian Bay area of Ontario, precipitation averaged about twice as much as normal. In Quebec, June was warmer than usual with Montreal, where the average temperature was 67°, being the warmest location in the country for the month. Ontario averaged slightly below normal although a 93° reported at Delhi was the maximum temperature reported throughout the country.

Atlantic Provinces. June was a pleasant month in the Atlantic Provinces on account of the minimum frequency of major cyclonic storms along the Eastern Atlantic seaboard. However, local thunderstorms, due to instability, were unusually frequent and precipitation averaged near normal. Conditions were nearly ideal for agriculture; in Nova Scotia haymaking proceeded apace and the strawberry crop was the best in years, while in Newfoundland farmers reported crops two weeks earlier than normal. Throughout the Atlantic Provinces temperatures were usually a few degrees above normal.

The North. It was a relatively warm month in northern Canada as the mid-Arctic coastal area from Chesterfield to Coppermine experienced temperatures 8 degrees above normal. Alert, the farthest north station, again was the coldest in the country with an average temperature of 32° and an extreme low of 18°. Except for the extreme southern portions of the territory, precipitation was considerably below normal and by the end of June there was an appreciable snowcover observed at only two or three stations.

ALASKAN NOTES

Juneau. Mean temperature this month of 51.1° was the lowest on record with the exception of 1955 and 1956. New records were established for the greatest amount of cloudiness and the least amount of sunshine. Max. 66°, min. 37°.

Fairbanks. Average temp. of 56° was 3.3 deg. below normal. Max. 78°, min. 33°. Precipitation of 0.73″ was 0.64″ below normal.

Barrow. June 21st was first day without a freeze. Average June temperature was 33.5° with a max. of 61° and a min. of 20°. Above freezing continually from 21st to 29th inclusive. Snow on ground reduced to a trace by 13th and entirely gone by 22nd. Precipitation of 0.29″ was just about normal.

HAWAIIAN NOTES

Honolulu. A new record all-time high temperature of 89° was established. June was slightly drier than normal with 0.18″. On 22 of the 30 days the mercury reached 85° or more.

PUERTO RICAN NOTES

San Juan. Second warmest June on record. Three new daily max. temperatures established and four equaled. All-time June max. of 93° set on the 3rd. Rainfall of 6.17″ was one inch above normal.

May *(Continued from page 171)*

skies along the coast in combination with a sharp freeze and a heavy snowfall at elevated areas.

Finally, on the 25th a pressure impulse from the Northwest low circulation moved eastward and by the 27th another marked closed low had formed over the lower Ohio Valley where the contrasting weather conditions of earlier May were repeated though in a much less pronounced fashion. This last major pressure feature of the month drifted northeastward, all-the-while losing strength until by Memorial Day air flow across the country had resumed a more normal west-to-east zonal path and the spread of Pacific air across the country brightened the weekend holiday skies for most areas.

May wore many faces as one might expect with deep low pressure vortices drifting slowly across northern United States and southern Canada. In the Northwest "winter lingering chills the lap of May" brought an unusually raw and wet midspring, but in northern New York and New England it was "wel-come be thou, fair fresshe May" as the month proved the most pleasant in many years. Temperatures averaged as high as 9 degrees above normal in Maine, there was adequate moisture for the start of the growing season, and the usual visitation of the mid-May freeze failed to materialize. The proverbial Ice-Saints went south this year to bring record low temperatures at mid-month to the Gulf Coast where the entire month averaged out as much as four degrees below normal. And out on the Pacific Coast Mount Shasta City (3544') had its snowiest May since records commenced in 1888.

Severe local storm activity proved less damaging than expected. Aside from the major tornado outbreak in Oklahoma on the 4–5th, death-dealing storms were less frequent than normal as the blocking effect over Canada prevented tropical air from remaining long in the Mississippi Valley. Polar air masses flowing down behind the slow-moving surface fronts in the mid-Mississippi and Ohio Valley ruled the usual scene of major tornado activity. Some occasionally heavy rainfall occurred along the stalled fronts in the Iowa-Wisconsin area and in northeast Oklahoma, and these were attended with considerable local flooding. In general, precipitation proved spotty.

MAY NOTES

Burlington, Vt. This was the warmest May since 1944 and one of the half dozen or so warmest Mays ever recorded here. This was the first May since 1953 without any snow and no frost or freezing temperatures occurred.

Boston, Mass. An unusually long period of excessive cloudiness, from the 8th to the 25th, that included two extended rainy periods marred this mild May. The month also included two periods of exceptionally fine weather—from the 2d through the 7th, and from the 26th through 30th.

Baltimore, Md. May was a cool, wet month. Total precipitation of 7.23″ makes this the second wettest May on record, being only 0.04″ short of the all-time wettest May which occurred in 1894. 3.80″ fell on the 8–9th in 24 hours with 0.33″ in 10 minutes.

Mobile, Ala. May was unusually cool and the 43° minimum recorded on the 13th was the lowest ever observed so late in the spring. Near records were established on the 8th, 9th, and 14th (48°, 48°, and 49°).

New Orleans, La. The low of 52° on May 12 is the lowest ever recorded so late in the season. Airport had 41° on the 13th.

Dubuque, Iowa. Wettest May since 1957. Most snow since 1935. The one inch of snow on 7–8th is the latest in the season for measurable snow and the greatest on the ground.

Williston, N. D. A very pleasant month with little above normal temperature and precipitation. No severe storms were reported in the area.

Concordia, Kan. May weather was near normal in every respect. No records were set and no major storms were reported.

La Crosse, Wis. The precipitation of 8.83″ was the largest for May since records commenced in 1873. 2.72″ fell in 24 hours on 16–17th.

Amarillo, Texas. This May tied with 1946 as the 5th driest in our 68 years of record. Only in 9 of the past 68 years has May failed to produce 1.00″ of rain. Ranges were suffering badly at the close of the month.

Oklahoma City, Okla. At least a score of tornadoes on each of the 4th and 5th caused widespread death and destruction. Preliminary reports indicate 31 dead, over 200 injured, and $3.5 million property damage. Cities hardest hit were Sapulpa and Wilburton. Hail of varying amounts and sizes at many scattered locations, some up to 4″ diameter in Woodward Co.

Salt Lake City, Utah. New daily highs were set on the 11th and 12th, and daily lows on 15th, 19th, and 22nd. The max. on 12th was also record high for so-early-in-season, and min. on 19th a record low. The one-inch snowfall on the 18th was the latest in the season that measurable snowfall has been recorded at the Airport.

Reno, Nevada. What little fruit in the valley had survived the freeze in late April was destroyed by the min. of 19° on the 22nd of May. With only a trace, this has been the driest May since 1943. Ranges are in poor condition . . . few reservoirs will fill to capacity.

Mount Shasta, Calif. New all-time records, dating back to 1888, were established for the greatest snowfall (16.4″) and the greatest depth on ground (6″). 14.2″ of heavy, wet snow fell on 23–24th and did a great deal of damage to trees and communications.

Olympia, Wash. This month continued the wet, cloudy trend that began last March. It was the first May of record which failed to produce at least one clear day. There were 23 cloudy and 8 partly cloudy days.

Los Angeles, Calif. Third warmest May of record —precipitation below normal.

CANADIAN HIGHLIGHTS MAY 1960

Record snowfalls in the Peace River country, a record warm month in southern Quebec, and the contrast of an exceptionally early spring in Nova Scotia as compared to a late spring in Ontario, were the features of the May 1960 weather in Canada. These occurrences were the result of a marked change over North America from a high index to a low index circulation pattern which occurred near the end of April and continued through most of May. This index situation was associated with two strong waves of blocking action at high latitudes which retrogressed across the north Atlantic Ocean to Baffin Island. With the main westerly current of air crossing the west coast of North America just south of British Columbia, which is farther south than was the case in April, British Columbia and Alberta had below normal temperatures during the month. Strong cyclonic circulation over the Great Lakes area was responsible for the general wetness in that region and for the above normal temperatures in eastern Canada.

British Columbia. Cold moist air from the Pacific Ocean kept unsettled weather over British Columbia during most of the month. Cloudy conditions prevailed on most days and at Victoria, Vancouver, and Prince George, it was one of the dullest Mays on record. Precipitation was generally heavy over the province with at least ten stations reporting in excess of 11″ during the month. Maximum amount reported was 15.63″ at Herbert Inlet on Vancouver Island. In the central interior, Prince George had 4.12″, making it the rainiest May in over 30 years of record. Most of British Columbia averaged from 3 to 4 degrees below normal temperature, and Lytton with a mean temperature of 57° was the warmest location in the province.

Prairie Provinces. A spell of hot weather centered on May 12th was the outstanding feature of May's weather in the southern Prairie Provinces. A high temperature of 99° was recorded at Moose Jaw which was only a few degrees lower than the all-time May high temperature record for Saskatchewan. At Regina where the temperature reached 97° on the 12th, it was a record high for so early in the season, and in fact there have only been three warmer May days since 1884.

Both total precipitation and snowfall records were established in the Peace River area near the Alberta-British Columbia boundary. On May the 21st and 22nd snowfalls of near 2 ft. were recorded from the Dawson Creek—Fort St. John area. Snowfall data from stations here for May greatly exceed any previously on record. Excessive rainfall occurred in southwestern Manitoba on May 25th when several stations reported in excess of 3″ for that day.

Ontario. Many stations in northeastern Ontario reported more than 6″ of rainfall during the month which, added to the melting snows, produced serious flooding conditions. As dams failed and roads and bridges were washed out, Timmins and Foleyet were virtually isolated. In southern Ontario despite the higher than normal temperatures, frequency of rain and the lack of drying days left the ground wet and delayed farm work. By the end of the month little work had been done on the land, and many agriculturalists were calling it one of the slowest or most retarded spring seasons on record.

Quebec. The heavily populated areas of Quebec experienced warmer and drier weather than normal. At Montreal, where city observations have been taken since 1875, a mean temperature of 63° was recorded, making this May the warmest over the whole period of record. Farther north in central Quebec, a few stations reported temperatures 8 to 9 degrees above normal for the month. Precipitation was well below normal and severe forest fires were reported late in the month north of Seven Islands.

Atlantic Provinces. In contrast to the slowness of the spring in Ontario, agricultural activity in Nova Scotia proceeded at an amazingly rapid rate. Precipitation was generally low and forest fire hazards were high most of the time. With the very sluggish eastward progression of weather systems, the cold dry air moving down over the Atlantic Provinces warmed rapidly. As a result mean temperatures were

everywhere above normal and several stations established both mean and extreme temperature records for May. The highest temperature reported was 96° at Grand Falls and five other stations in New Brunswick reported temperatures in excess of 90° on at least one day.

The North. Alert and Isachsen with mean temperatures of 15° were the coldest locations in the nation during the month. Minimum temperatures of −12° at these two locations were also extremes for Canada as a whole. On the other hand, some exceedingly high temperatures were reported from the Yukon Territory where Dawson had a maximum of 86°. Most of the Arctic was from 2 to 6 degrees above normal over the month, while the upper Mackenzie basin averaged near normal. Exceptionally light precipitation was reported throughout the north; in fact, most areas were well below normal. By the end of the month, the only snow cover left in Canada was north and east of a line from Port Radium to Churchill to Fort Chimo. The maximum depth was at Clyde where on May 31st 26″ were reported on the ground.

ALASKAN NOTES

Juneau. This was an unusually pleasant month with the monthly mean temperature of 49.5° being 0.2° above the previous record made in 1946. Sunshine was 6% above normal and cloudiness was below. The max. 73°, min. 30°.

Fairbanks. This month was the warmest May on record. In a late-month heat wave max. exceeded 80° on three consecutive days. Max. 89°, min. 29° —average 53.1°. Precipitation only 0.26″, or 0.48″ below normal.

Barrow. It was a windy month with an average wind speed of 15.9 mph. Temperature did not rise above freezing until the 23rd. Minimum did not sink below zero. Max. 35°, min. 3°. Snow cover reduced from 14″ to 3″ by 31st.

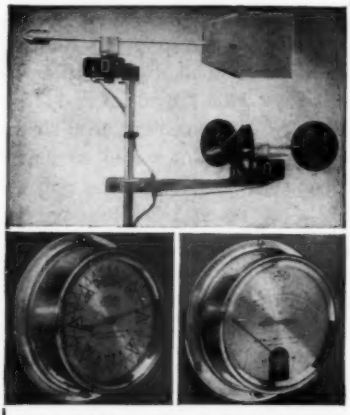
HAWAIIAN NOTES

Honolulu. The thunderstorm activity observed on the 12th–14th was associated with a 500-mb low which became cut off over the Islands. Although distant lightning had been observed in May, these are the first May thunderstorms of record. Rainfall was a May record—3.85″ or 3.45″ above normal.

Hilo, Hawaii. Tidal wave alert on May 22nd. Wave struck at 0015, May 23rd, causing over $50 million damage, 57 lives lost, and 4 missing. Max. 84°, min. 62°.

PUERTO RICAN NOTES

San Juan. Temperature averaged 1.5 degrees above normal, and precipitation 1.48″ below normal. Max. 90°, min. 73°. Lowest max. 83°. Highest min. 78°.



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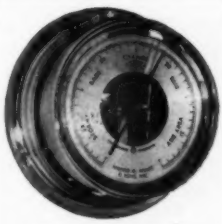

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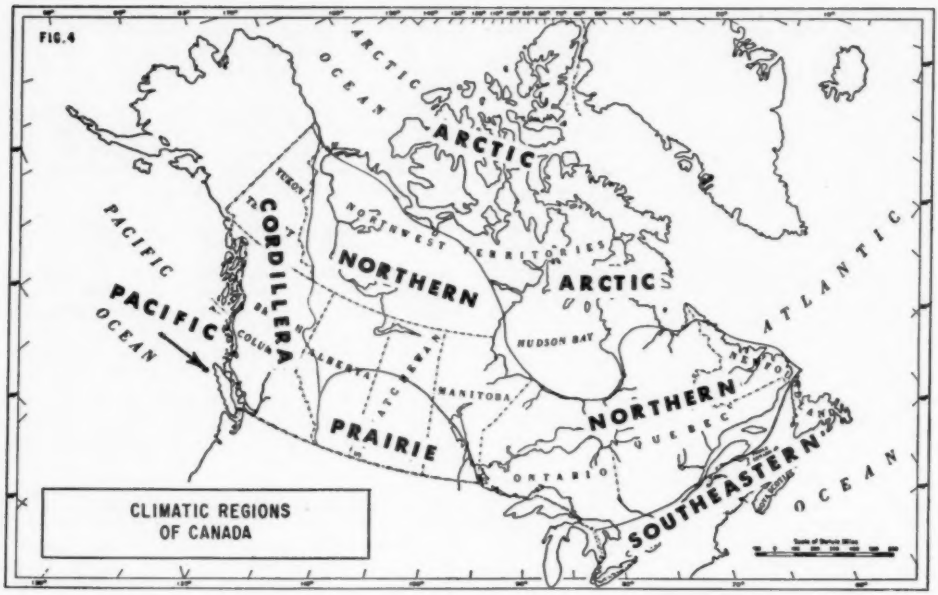

THE CLIMATE OF CANADA

Canada is a land of many climates. Frigid wind-swept barrens, hot sun-ripened grain fields, dusty scanty grasslands, and wet heavily forested slopes are all part of the Canadian landscape.

The varied weather and climatic pattern of this vast area of North America, which stretches from a few hundred miles of the North Pole to 42°N and almost one-quarter of the way around the world, is the subject of a concise and informative article prepared by C. C. Boughner and M. K. Thomas of the Climatology Division, Meteorological Branch, Department of Transport, Toronto. The *Climate of Canada* first appeared in the *Canada Year Book 1959–60* and is now available as a booklet to *Weatherwise* readers at request to the Director of the Meteorological Branch, Department of Transport, 315 Bloor Street West, Toronto 5, Canada.

The 74-page booklet opens with a three-page section discussing the six major climatic zones of the country. This is followed by a detailed breakdown into Provincial and Territorial climates, with the discussion of single provinces again broken down into as many as three different sub-divisions. The bulk of the publication is taken up with well-arranged tables which enable one to determine quickly local data for any month of the year. A concluding page supplies references and gives the location of source material for those who wish to probe deeper into the subject.

We learn that the highest temperature ever registered at an official Canadian station was the 115° reading at Gleichen, Alberta, on 28 July 1903. The lowest occurred at Snag, Yukon, on 3 February 1947. Also that Henderson Lake on Vancouver Island, British Columbia, with a 14-year average of 262″ holds the record for annual precipitation on the North American continent.

Summer Study Center

The American Meteorological Society-Loomis School Atmospheric Sciences Center at Windsor, Connecticut, has concluded its second summer session. This year there were two parts to the program: (1) the regular program for high school juniors, and (2) an advanced phase for 10 of the students who had attended last year. The entire program is supported by the National Science Foundation and operated by the AMS and the Loomis School at Windsor, Connecticut. Dr. Vincent J. Schaefer has again served as director of the Atmospheric Sciences Center.

Forty students from 15 states attended the regular program. They were selected from several hundred applicants. The general nature of the course and the type of experiments pursued were outlined in *Weatherwise*, October 1959. Dean George B. Savage writes: "Things at the Center are running very smoothly and busily. We have an excellent group of students and young instructors. The Advanced Phase which includes ten students who attended The Center last summer is a very exciting experiment."

The Weather of Oregon

"Oregon's energetic weather contributes a great deal to both the wealth and the talk of the state," comments Dr. Fred W. Decker, author of the informative 40-page booklet, *The Weather of Oregon,* recently issued by Oregon State College.

This pamphlet outlines some of the interesting facts about the causes of Oregon's weather and tells of some of the services available to the people of the state. Readers will not only gain worthwhile information and insight from this, but will learn also to use the professional weather services to serve their best interest for business and pleasure. Included are some helpful hints for the amateur forecaster, as well as schedules of radio sources of current weather data. Climatic records are provided for general reference.

Copies of *The Weather of Oregon* may be secured for $0.50 from the Office of Publications, Oregon State College, Corvallis, Oregon.

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Tornado Producing Cloud Seen From Tiros I

The above photograph was taken by Tiros I about 1400 CST, 19 May 1960, when the wide-angle camera scanned the Southern Plains area of the United States. The bright, "square" cloud image in the lower right hand corner is centered approximately 50 miles west-northwest of Wichita Falls, Texas, close to the Texas-Oklahoma border. The large cloud area in the left portion is associated with a storm centered in Kansas.

Satellite meteorologists of the U. S. Weather Bureau discovered this striking and unusual photograph which showed an isolated group of clouds appearing as a bright "square" in an otherwise cloudless part of the sky. From cloud analysis and locations obtained through the use of a cloud schematic, the "square" cloud mass was determined to be precisely in the area of heavy thunderstorm activity reported at the Texas cities of Hobart, Childress, and Wichita Falls late on the afternoon of 19 May. The analysis also produced strong evidence that this cloud mass later expanded and spread northeastward, spawning tornadoes and hail in central Oklahoma.

Satellite meteorologists consider this discovery a stroke of luck. David S. Johnson, head of the Weather Bureau's satellite section, declared that not every isolated cloud mass seen from satellite vehicles will warn of impending severe weather. He pointed out, however, that detection of unusual cloud masses, when considered with their geographical location, the climatology of the region, and the existing weather situation, may well enhance the meteorologist's ability to recognize and pinpoint small-scale severe weather situations.

Tiros I Film

A 15-minute, 16 mm, sound motion picture in color is now available for free loan to Local Branch Meetings of the AMS and other educational groups. The film, which was produced for the Radio Corporation of America, describes the development of the Tiros project, its present operation, and gives a brief glimpse into the future of satellite meteorology.

The film is free on loan from: Office of Technical Information and Educational Programs, Technical Information Division, National Aeronautics and Space Administration, Code ET, 1520 H Street, NW, Washington 25, D. C. or "Tiros Film," Sterling Movies, U.S.A., 43 West 61st Street, New York 23, N. Y.

Josiah Meigs

(*Continued from page 167*)

Weekly Register. Professor Meigs writes in 1819: "The politeness of the Registers of land offices of the United States and of several other gentlemen, has enabled me to collect meteorological facts and observations for nearly twenty years past."

Professor Meigs was indeed a pioneer weatherman and, had his plan been adopted by the Congress, this country's organized National weather service would have been established much earlier than it was. The resulting records would, no doubt, have been very useful, especially to those attempting to study or detect long-term trends or changes in the climate of the United States.

WEATHER SUMMARY FOR ATHENS, GEORGIA—1805
As Reported in the Augusta *Georgia Chronicle*
of February 1, 1806 by Dr. Josiah Meigs

Average monthly temperature

Month	Average °F
January	44.90
February	47.25
March	55.90
April	64.96
May	69.64
June	78.30
July	81.30
August	78.20
September	77.50
October	54.10
November	54.83
December	52.45
Year	62.90

Highest temperature:	100° on July 7
Lowest temperature:	6° on January 22
Last Spring frost:	April 28
First Autumn frost:	October 3

Wind Directions		Weather (3 years)	
North	24	Clear days	688
Northeast	36	Cloudy days	166
East	3	Rainy days	169
Southeast	26	Thunder	71
South	35	Snow	1
Southwest	113	Rainiest month—July	
West	40	Cloudiest month—March	
Northwest	88	Clearest month—December	
		Most thunder—August	

Volunteer Observers Cited by Weather Bureau

The Weather Bureau has announced that 37 co-operative weather observers will receive the Bureau's new Thomas Jefferson and John Campanius Holm Awards in 1960. See *Weatherwise*, April 1960.

The Thomas Jefferson Award is so named because the third president kept an almost continuous record of the weather from 1776 to 1816. The winners of the Jefferson Award for 1960 are:

Mr. Phil Brogan, Bend, Oregon
Mr. S. S. Judy, Forestburg, S. D.
Mr. Albert M. Foss, Pauls Valley, Okla.
Mr. Louis Hardtla, Philo, Ohio
Mr. Henry M. Reusser, Berne, Ind.
Dr. J. G. Standifer, Blakely, Ga.
Miss Amy Ann Stern, Logan, Iowa

The John Campanius Holm Award is named for the first known systematic weather observer in what is now the United States, who took daily observations without instruments in 1644 and 1645. Recipients of the Holm Award for 1960 are:

Mr. Richard C. Brigham, Fall River, Mass.
Mrs. Ernest Burrus, Burrus Ranch, Ariz.
Mr. Carlos A. Call, Fort Ross, Calif.
Mrs. Tirzah Miley Coates, Woodstock, Va.
Mr. Lindsay W. Crook, Heber, Utah
Mr. Irwin A. Draper, Red Lodge, Mont.
Dr. Hallie Earle, Hewitt, Texas
Mr. Walter O. Eckert, Grapeview, Wash.
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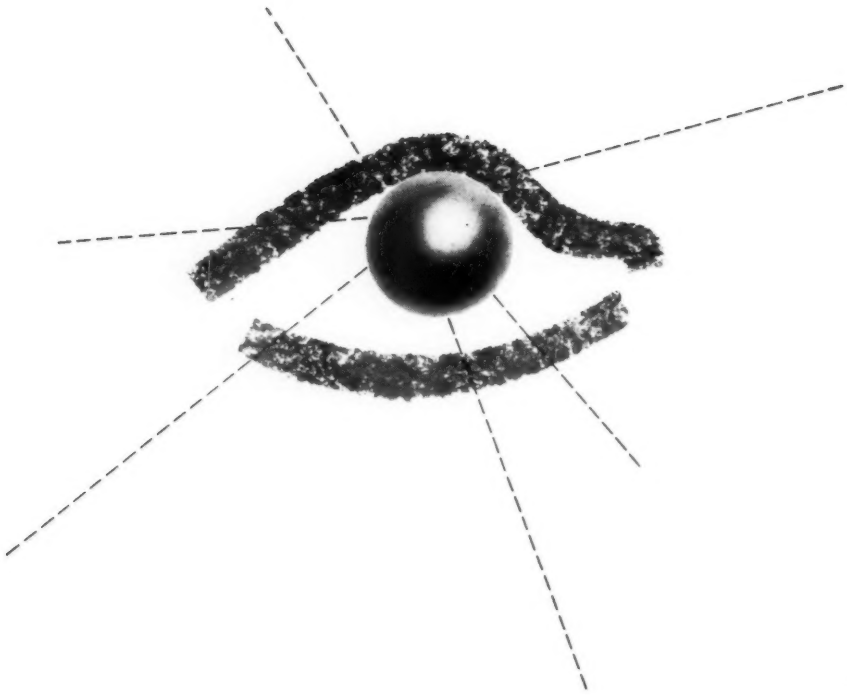

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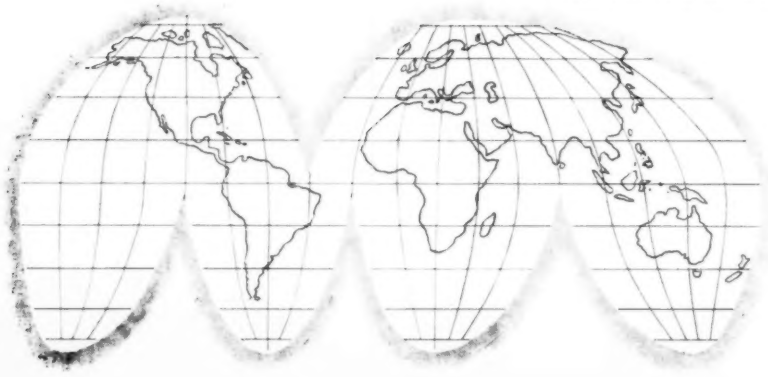
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